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CENTRALIZED PLANNING AND THE HUMAN FACTOR

THE lectures on "Central Planning and Control in War and Peace", which were delivered by Sir Oliver Franks at the London School of Economics and Political Science during February and March and have since been published*, are a notable contribution to the discussion of forms of government required to serve our post-war needs. The outcome of the war-time experience of a philosopher who proved himself a successful administrator in the Ministry of Supply, they bear closely on the issues involved in numerous questions of current debate. Sir Oliver indeed limits himself to one topic, which he chose because of its fundamental importance in relation to the general pattern of economic activities in Britain during the coming decade; but much of what he has written is as relevant to discussions in other fields, such as the use of the scientific resources of Britain, and the numerous issues in town and country planning which have led to recent controversies.

The whole question of central planning and control is in fact controversial, and Sir Oliver recognizes that the application of central planning and control in peace must alter traditional conceptions and methods so extensively as to change the whole framework of economic activity. Central planning and control in peace are likely to be just as disturbing to the thoughts and habits of Governments dealing with business as to business itself. Whether such planning and control of the economic life of Britain is inevitable in the next decade is far too serious a question to be settled without deliberate and reflective discussion.

Sir Oliver draws on his war-time experience for his contribution to the discussion, and his reflexions lead him to conclude that some form of central planning and control is inevitable, and that the issue is not one which may be decided one way or the other according to the general political views of the party from which the Government is formed. This does not mean that the vast fabric of control organisations created during the War has to be re-created in peace, or that control in detail over so wide a field will be necessary. It is a question, too, which affects equally both private and public enterprise; but does not raise any issue between them or advocate a doctrine of nationalization. But it does mean that, so far as matters of principle are concerned, the subject should be withdrawn from political controversy.

This conclusion is based on consideration of military security, of the fear of unemployment and of the general condition of the world, all of which, conjoined with the special relation in which foreign trade stands to the British economy, suggest that no Government in the foreseeable future is likely to dare to do without export programmes and import programmes centrally planned and controlled. That is the position reached in the first lecture; but there is much more in the lecture. In his survey of the activities of the

* Central Planning in War and Peace: Three Lectures delivered at the London School of Economics and Political Science on the invitation of the Senate of the University of London. By Sir Oliver Franks. Pp. 61. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 2*s.* 6*d.*

raw materials organisation of the Government to illustrate the way central planning and control worked in a particular field, Sir Oliver makes clear some most important points.

This type of central planning only works if those who are involved in the decision feel bound by it and are convinced by rational considerations that what is proposed is as fair and reasonable as can be in the circumstances. A general plan or allocation is a practical directive for ensuing action, and it is necessary that the principal agents should acknowledge a commitment to the decision. Again, after planning comes the problem of control. Here the first function is verification of fact, and the second to ensure enactment; and what Sir Oliver brings out is the flexible character of the organisation built up for such purposes during the War.

Now if Sir Oliver is right in his conclusion that some form of central planning and control must in future characterize British economy, much that is done in the transitional years could be a constructive preparation for the longer years of peace. The essence of planning and control by the State in relation to productive industry and commercial activity is the same in war and in peace: decisions of policy quantitatively expressed in the form of programmes and such measures as in particular circumstances are necessary to ensure the performance of these programmes. Such planning and control, in fact, are normal characteristics of all practical activity that is in any way reflective, and in the field discussed by Sir Oliver the decisions which the State takes on its own responsibility and initiative are industrial and commercial decisions, and diminish the field in which business can display the same qualities by providing a framework of policies within which other similar but less general decisions must be made.

It is for this reason that what Sir Oliver has to say in his second lecture on the weaknesses of really large-scale organisation is important. Such weaknesses could scarcely have been explained better; the Civil Service has no monopoly of bureaucracy. The dangers of woolliness and inflexibility and inertia are admirably set forth, and special stress is laid upon the importance of effective communication and of foresight. Here again Sir Oliver draws on our war-time experience to find some clues to the principles upon which central planning and control could be organised in peace to have a reasonable prospect of success in the economic field.

The first and essential problem is that of purpose; and the main difficulty in central planning in peace is that of finding a common purpose understood and accepted by the nation and compelling support as the common objective. That involves much intelligent work in what may be described as the field of public relations; but it also involves much on the Government side that at present appears to be commonly disregarded. Central planning means, for example, that it is no longer possible for a Government to have a number of policies each of which can be pursued independently of the others. Housing, social security, exports, education, and defence are all factors in the general plan; the extent to which resources can be devoted to each is determined when the general balance is struck. It is also the Government's responsibility to create the necessary unity of purpose by the deliberate application of human intelligence and will.

There are other implications. Adoption of central planning and control in peace commits the Government to selecting and defining the ends of the national economy as an essential part of its planning and controlling activities. It engages the Government to a radical re-definition of its function in the economic field and to the shaping of situations before they arise. All this demands a real revolution in traditional habits of thought and makes a heavy call on leadership; and Sir Oliver makes it clear that reasonable success depends on the diffusion of initiative throughout the organisation and not on the Government side only. The Government, it is true, must take the general decisions involved in the programmes, but these should be kept as few as possible.

If initiative is to be diffused, clear and understood division of function is also essential. There must be no doubt where Government leaves off and business begins, and allocation of responsibility must follow. Exercise of initiative requires not only a job to do but also knowledge of responsibility for it. Responsibility for different functions must be placed, without equivocation and without strings, on those who perform them; and not the least valuable part of this admirable lecture is the way in which Sir Oliver drives home the implications. Beyond doubt he points the way to the establishment of that mutual confidence and understanding between industry and business and Government, whether Ministers or Civil servants, which are at the very root of effective planning and control.

The stress which Sir Oliver lays here on precision of thought and definition of responsibility, if the inherent woolliness of bureaucracy is to be overcome and the temptation resisted to avoid mistakes rather than to seize opportunities, makes a pertinent comment on current affairs. No less important, however, are his observations on what is involved in this method of agreement, which as he truly says is that of democratic procedure, reconciling equality of status with difference of function. It means that the Government must refrain from treating industry and commerce as instruments of its policy, and regard them instead as equal partners in the national enterprise with different but complementary functions. Agreement, moreover, is only possible when each party understands the mind of the other and full explanations are given of what is proposed, and there is free discussion on the basis of full information.

It would be idle to pretend that there at present exists either the full confidence in which such discussion and partnership can be fruitful or the balance of policies on the Government side which is essential to central planning. In his concluding lecture, however, Sir Oliver discusses the practical possibilities of achieving such a solution as he suggests, and the advantages which Great Britain has derived from its war-time experience and which, if used intelligently, could ease the transition. Chief among these he puts

the more extensive and detailed knowledge of industry and commerce which the Government now possesses, the contacts between the Civil Service and industrialists, the experience which Government departments have gained in the methods and techniques needed for central planning. Moreover, many of the younger men who have returned to business life with a knowledge of the Civil Service from inside are now missing the satisfaction of doing a job which is related in a direct and intelligible way to the national need.

This question of incentive is more important than is yet generally realized, and Sir Oliver Franks is profoundly right in suggesting that for the future of Britain it would be a good thing to add to the dignity of work. He writes pertinently also on that vital factor, the co-ordination of Ministerial action, and leans to the idea of a Minister without departmental responsibilities as chairman of a committee of the Ministries concerned. Equally his own experience lends weight to Sir Oliver's comments on the functions of Civil servants in central planning, and his suggestions that it should be a first concern of the Civil Service to increase the number of experts at its disposal who are qualified both by training and knowledge of the world for the forecasting and estimating on which programmes must be framed and decisions based, and his reminder that right decisions and sound judgment depend on a fresh mind with some degree of leisure, are timely. The tendency to overload both Ministers and departments is probably the most serious consequence of the present tempo of the Government's programme, and may well be one of the hindrances to securing much freer and more spontaneous interdepartmental co-operation.

Sir Oliver is sceptical as to the value of an economic general staff, and suggests rather that the Government should encourage the formation of groups of industrialists and businessmen, strengthened by the inclusion of an academic economist and a trade union leader, with a Civil servant as chairman and terms of reference supplied by the Government. Such groups could do something to lessen the burden which planning imposes on the Civil Service, and the appointment of special assistants relieved of administrative departmental duties and free to think and plan might also lighten the burden of permanent secretaries and their deputies, if such assistants can work effectively with the main organisation.

These suggestions admittedly only touch the fringe of the difficulty, but to lighten the strain on senior Civil servants is one of the most urgent problems if central planning is adopted; and it is not the less imperative because of the responsibility which will also rest on the Civil Service for bringing industry and commerce effectively into the formation as well as the execution of plans. It is true that a new outlook on the part of industry and commerce will be required, and no matter how clearly the problem of communication is handled from the Government side a large responsibility must fall on the trade associations. Such bodies must be prepared to forward the initiative of their members within the general plans of the Government, and they must be much more concerned with the calibre of their representatives.

Nothing in these lectures encourages facile optimism as to the elaboration of the necessary organisation for planning. The stress is indeed on the human aspect and the time factor which must be allowed if we are to arrive at the sense of the meeting and collaboration which lies at the root of the democratic method.

These organic and human aspects of government are, indeed, the critical factors in any system which is to preserve the essential freedoms and the great intellectual and cultural traditions of civilization in any sphere of life, and not the less so in that the agenda of government is increasingly concerned with scientific and technical matters. Sir Oliver makes it abundantly clear that scientific method has much to contribute to the task of government, although he does not bring out so clearly as Sir Ernest Barker has done how much the method of democracy has in common with the procedure of science itself. The controversies over the Bankside Power Station and military training areas, or the development of a university policy or the most effective utilization of the nation's scientific resources in materials or man-power must indeed be resolved in part at least on a basis of fact, for the determination of which the method of science is required. But they also demand consideration of the human and social factors, if there is to be laid bare the common interest which will call forth the loyalty and the voluntary co-operation on which democratic planning depends for its success.

Sir Oliver Franks does not take us very far in his discussion as to how this is to be achieved. Prof. K. C. Wheare recently reminded us of the potential value of advisory bodies, and Sir Oliver's proposal for the formation of groups recalls some of the proposals for constitutional reform issued by a group of the Conservative Party last year. These proposals also included drawing on war-time experience to build up a system of sub-committees designed to secure the co-operation of able men from industry and trade and organised labour and to provide Government with something in the nature of an informal economic advisory staff, in addition to the existing Economic and Statistical Sections of the Cabinet Secretariat. Here, too, the emphasis is laid on quality rather than on the representation of interests, and the ultimate test of democratic planning will come just at this point of its capacity to develop the sense of the common interest which will secure the consent and co-operation of the Government.

That is brought out as soon as we examine in detail any problem of practical planning, whether in such diverse fields as the utilization of land, power and hydro-electric schemes or the expansion of the universities. There must indeed be some adequate and efficient administrative organisation with resources and authority to execute the policy decided. But the means by which that policy is decided is the all-important factor in a democracy. It must include not merely the fact-finding facilities, but with them a technique and system of discussion which will assist in the formation of a public opinion and a general sense of common interest ensuring agreement

and support for what is decided. In these lectures Sir Oliver Franks has set forth very faithfully some of the grave dangers inherent in any bureaucracy, no matter how great its merits. But while he reminds us of the importance of efficient organisation and respect for proved principles, he does not fail to point out that the man is more important than the machine. Whether our post-war organisation of Government proves equal to the immense tasks confronting it does not depend primarily upon the wisdom of our planning in the technical sense. It depends largely upon the men and women to whom the execution of those plans is entrusted. Nor is it simply a matter of their personal integrity, administrative ability and scientific and technical knowledge. It is a question of their physical ability to meet the strain. That, in turn, depends in part only on their numbers. Above all, success depends on whether in the preparation of plans and the formulation of policy the right steps have been taken to secure the approval and co-operation of the general body of citizens whose interests are to be served.

ECOLOGY OF NORWAY

Sikilsdalen og Norges fjellbeiter

En plantesosiologisk monografi. Av Rolf Nordhagen. (Bergens Museums, Skrifter Nr. 22.) Pp. xvi+607. (Bergen : A/s John Griegs Boktryckkeri, 1943.) 30 kr.

LOVERS of Norway, plant geographers, ecologists and systematists in many countries have cause for gratitude that Prof. Nordhagen's monumental study of Norwegian mountain vegetation in general and of Sikilsdal in particular was successfully published in 1943 in spite of enemy occupation of the country. The book is the culmination of twenty years indefatigable pioneer work, and the only cause for regret is that its weight and quarto size preclude its being carried in the pocket by a visitor. In every botanical library it should, however, find a place.

As explained by the author, the work is primarily a review of the ordinary mountain vegetation of Norway, exceptional areas, no matter how interesting, being on this occasion left aside. The vegetation is prevailingly that of non-calcareous or poorly calcareous districts with Sikilsdal as the fixed starting point. From the practical point of view it is the region of mountain pasture for horses, cattle or (formerly) reindeer, and the instruction of the potential user is constantly borne in mind in the presentation of the scientific descriptions. Indeed, some of the illuminating details intended for the guidance of the practical man are not the least interesting of the contents, the botanical criteria for the detection of late-lying snow pockets (of importance to a railway engineer) being a case in point.

Prof. Nordhagen's aim has been to reduce the bewildering details of his country's vegetational types into a manageable system of recognizable units, defined in such a way that comparison with other countries, notably Sweden, Finland and Central Europe, can be carried out, and by doing so to introduce into Norwegian science a standardized ecological language. This, and not the political vicissitudes prevailing at the time of publication, is the reason why the work is written in Norwegian rather than in some other language of perhaps wider currency; and quarrel with this decision cannot be made, for it will certainly strengthen considerably the further prosecution of ecological research in the author's own country. The non-Scandinavian reader need not, however, be unduly disturbed. The basic ecological classification was published in a preliminary form in German in 1936, and the book itself is very well supplied with indexes, table of contents, diagrams, tables and illustrations from which much information can be gleaned with little need of a dictionary.

The main climatic divisions utilized are first the separation of alpine from subalpine, the latter characterized by birch wood, and secondly, the subdivision of the treeless alpine zone into three regions, the low, middle and high alpine, the last being unrepresented in Sikilsdal. Within these zones the vegetational units are grouped under the following main heads, each containing several subdivisions: dwarf-shrub heath, dry grass heath, the vegetation of the sites of late-lying snow, tall herbaceous mountain vegetation, mountain meadow and grass pasture, nitrophilous weed vegetation near hutments, the vegetation of springs and of open water, grass moors, ericaceous moors, vegetation of unstable ground (screes, etc.), vegetation of precipices. In many cases, for example, in the masterly treatment of the complexities of grass moors, the classification is put forward as provisional, but even in such cases enough is known from the work of other writers to suggest that the units put forward have a validity and usefulness not merely for Norway but also for other northern countries.

It is impossible in a review to quote in any detail the scientific content of a work as richly filled as this. To a British botanist not the least of its value is the light that it can throw on many obscure features of the vegetation of our own islands. Peculiar and rare species, *Scheuchzeria palustris*, *Betula nana*, *Salix lanata*, *Phyllodoce cærulea*, *Athyrium alpestre*, to quote a few at random, too uncommon with us to be adequately studied, fall into an intelligible place as relicts of a former age, in the light of Prof. Nordhagen's remarks. Indeed, it may be said with confidence that this description of Norway is likely to contribute more to an understanding of the general ecology of Scotland than has accrued from work done in that country for many years past.

I. MANTON

CRUDE DRUGS AND OTHER RAW MATERIALS OF VEGETABLE AND ANIMAL ORIGIN

Textbook of Pharmacognosy

By Dr. T. E. Wallis. Pp. ix + 504. (London : J. and A. Churchill, Ltd., 1946.) 28*s*.

ONE would naturally expect a high standard of attainment from the specialists who are responsible for the teaching of pharmaceutical subjects in the College of the Pharmaceutical Society of Great Britain. By virtue of its connexion with a body in which is vested the authority to grant diplomas for the practice of the craft of the pharmacist, it is right that the College should give a lead to those institutions concerned with instructing men and women for this profession. It is pleasing to see,

therefore, that Dr. T. E. Wallis has produced a volume which maintains this tradition as regards pharmacognosy, following as he does the example of the late Prof. H. G. Greenish.

It is interesting to trace the development of this subject, during the past five decades, under these two men, both of whom have had a large share in establishing pharmacognosy in Great Britain on firm foundations as an important applied science. Dr. Wallis's influence is particularly seen in the appropriate monographs on drugs in the British Pharmacopœia and the British Pharmaceutical Codex. Greenish first published his "Introduction to the Study of Materia Medica" in 1899. The sixth and last edition, entitled "A Text-Book in Pharmacognosy", appeared in 1933 and embodied the changes in the revised British Pharmacopœia of 1932. This was the standard text-book in Great Britain over this period. Meanwhile Dr. Wallis, who had become more directly responsible for the teaching of pharmacognosy at "The Square", published a "Practical Pharmacognosy" in 1925. The fourth and last edition was published in 1943. First under Greenish, then independently, Wallis has exerted considerable influence on the concept of pharmacognosy, whether for the requirements of the Pharmaceutical Society's qualifying examinations or for the training of students in this subject.

Synchronizing as it does with his retirement from active teaching, we may assume that Dr. Wallis's text-book represents his mature views on pharmacognosy. Its scope is great and varied, and yet the ground is covered with that meticulous care for correctness of detail so characteristic of the man. His wide range of knowledge of plant and animal organisms and their products is most impressive. Every aspect of the subject is thoroughly explored and presented with a wealth of illustration which makes the subject-matter both interesting and instructive. Recent research and present trends in research are included. Contributions to research by Dr. Wallis and his school have been largely in the field of quantitative microscopy, in the devising and extending of methods for estimating amounts of admixture and sophistication in powdered drugs, so as to ensure conformity to legal requirements.

Dr. Wallis's classification of the subject-matter is based upon some fundamental characteristics which bring drugs into large groups each having some particular feature in common. Morphologically similar plant organs or tissues are grouped together, such as woods, barks and galls, leaves, flowers, etc. Plant products, extracts, etc., are grouped according to their nature into gums and saccharine substances; resins, gum-resins and oleo-resins; fixed oils, fats and waxes; and so forth. For teacher and student this arrangement has distinct advantages. Discussions of general principles are deferred to the end of the book. It is doubtful if all teachers of pharmacognosy will agree with the order of arrangement of the material. It must be remembered that many students entering a course in pharmacognosy have only had training of the standard laid down by the syllabus for the Pharmaceutical Society's Intermediate Examination. The reviewer feels, therefore, that to introduce the detailed histology of woods and barks near the beginning of the book is to expect rather much from such students.

Several minor corrections will need to be made when the text-book is revised. For example, it will be noted that a number of specific names starting with capital letters in the text have small letters in the captions to figures and in the index. Thus, Figs. 124 and 125 and also the index have *Datura stramonium*, the text *D. Stramonium*. The reviewer ventures to suggest that the author also includes available stomatal index numbers along with his other criteria in his descriptions of the respective drugs.

The text-book supplies much valuable information and carries with it the authority of a careful investigator and an experienced teacher. It is to be strongly recommended to teachers, students and all who are interested, directly or indirectly. His many friends hope that Dr. Wallis, in his retirement, will long be spared to maintain his vital interest in a subject he has made peculiarly his own, and will continue to give guidance and counsel to those who may be called upon to shape its further development and progress.

The publishers are to be congratulated on a work of high merit, even though still limited by Government austerity regulations. It would have been an advantage, however, if the text-book and Wallis's companion volume, "Practical Pharmacognosy", could have been made to conform in size.

W. O. HOWARTH

FUEL PRACTICE

Fuels, Combustion and Furnaces

By Prof. John Griswold. (McGraw-Hill Chemical Engineering Series.) Pp. vii+496. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 27*s.* 6*d.*

THE reader of this book can scarcely fail to notice how technical literature has developed during the past generation. Books used by students formerly were mainly descriptive. This applied to fuel technology—a subject amenable in part to considerable quantitative physical treatment. It includes industrial operations involving chemical reactions on the largest scale and of the greatest intensity. Indeed, some of these were used by the early pioneers in their studies of thermodynamic principles. It is not surprising that in time writers found it necessary, in the interpretation of technical processes, to use modern physical chemistry. In the United States, Haslam and Russell in 1926 produced their book on "Fuels and Their Combustion", which gave to many students the first approach of this kind. Since then developments in practice have taken place, and more particularly in petroleum technology. This deals in the main with liquid materials. These lend themselves especially to physical treatment, which is reflected by several chapters in this book by Griswold. While giving an account of fuel practice, at any rate of American practice, it is sprinkled throughout with references to modern physico-chemical theory. This should be advantageous to many students who find difficult the same approach by way of text-books of abstract theory. There are many who would find the grasp easier when theory is associated with industrial processes.

In conclusion, one can say that the author has realized the aim of his preface, "to satisfy the need for an up-to-date chemical engineering text in this important field. It is the first attempt since that of Haslam and Russell twenty years ago to bring together an essentially fundamental background with developments in both theory and practice."

H. J. HODSMAN

THE CHEMICAL SOCIETY

By Dr. F. SHERWOOD TAYLOR

DURING July 15–17 of this year the Chemical Society is celebrating its centenary, which but for the War would have taken place in 1941.

The early scientific societies extended their activities to all branches of science; it was only at the beginning of the nineteenth century that societies for the study of special branches of science began to be formed. The Astronomical, Linnean and Geological Societies belong to this period. The Chemical Society was the first national body to take chemistry as its sole object of study, for it was not until 1857 that the French Chemical Society was formed, while the Berlin Chemical Society did not originate until 1868.

In the early nineteenth century there was a considerable body of Englishmen eminent in chemistry —the names of Dalton, Davy, Wollaston, Faraday come to mind. In the eighteen-forties, however, the main activity in the science was on the Continent, where Liebig, Wöhler, Bunsen, Dumas, Gerhardt and Berzelius were at the height of their powers. The British chemists of the time were well aware of the importance of the subject, both for pure science and for industry, and the first attempts to form a society met with a warm response. The moving spirit was Robert Warington, who on February 23, 1841, convened a meeting "for the purpose of taking into consideration the formation of a Chemical Society", which was duly constituted on March 30. Thomas Graham became president; Brande, Daniell, Clark, Daubeny and Grove were among the officers. The purposes of the Society were stated in the following words: "for the advancement of Chemistry and those branches of science immediately connected with it, for the communication and discussion of discoveries and observations relating to such subjects: the formation of a Library of scientific works and of a Museum of Chemical preparations and Standard Instruments are also ulterior objects of the Society". All these intentions, excepting the last, towards which only a beginning was made, have been carried out in a manner that its founders can scarcely have anticipated.

The Society began work at once and published from time to time *Memoirs* and *Reports of the Proceedings*. Membership increased, and in 1849 a Royal Charter was obtained.

The first meetings were held in the premises of the Society of Arts; in the same year they were removed to the Westminster Literary and Scientific Institution at 47 Leicester Square; but in 1843 returned to the Society of Arts. In 1850 the Society moved to 142 Strand, then to Cavendish Square, where it occupied a part of the premises of the Polytechnic Institution. About 1853 the Government promoted a plan for accommodating the scientific societies at Kensington Gore, but this found little favour. The Burlington House site was proposed instead, but it was not until 1874 that the new buildings were ready and the Society entered upon the premises it has now occupied for nearly three-quarters of a century. In that year its fellows numbered 733; to-day they number more than seven thousand, and in view of the parallel expansion of numbers both of men and books it is not surprising that further expansion has been in question.

The "communication and discussion of discoveries", set out as the Society's first intention, has been carried out by the reading and discussion of papers, and their publication. It is impossible to estimate the value of the thousands of discussions that have taken place at its meetings, opportunities for the sharing of ideas or the no less valuable clash of opinion, which has so often had the result of leading the research worker to re-examine his conclusions, clarify his explanations and reinforce his experimental proofs. We know that much of the work that led to the adoption of the correct views concerning atomic and molecular weights was done at these meetings, and in some instances by men, such as Odling, whose published work was comparatively unimpressive. These meetings have been of especial value to junior research workers, who find in them at once a means of contact with senior workers of reputation and experience and a strong encouragement in an often ill-rewarded pursuit.

The editors of the *Journal* have likewise done much to maintain the high standard of experimental proof for which the chemists of Britain are justly esteemed. The printing of scientific papers was among the first of the Society's activities. A volume of *Proceedings* and another of *Memoirs* appeared during 1841–43; these were followed by two volumes of *Memoirs and Proceedings of the Chemical Society of London*, and between 1847 and 1864 by fourteen volumes of the *Quarterly Journal*, which contained not only original papers, but also abstracts and official reports. During 1862–71 a *Monthly Journal* was published. Space was always a difficulty, and during this period abstracts were no longer published, but in 1871 "Abstracts of Chemical Papers published in British and Foreign Journals" were included in the *Journal*. From 1878 onward the *Transactions* and *Abstracts* were separated, while from the year 1885 the *Proceedings*, which had previously been scattered through the *Journal*, were separated and form a record of the Society's business and activities. After 1914 these were published in an abbreviated form with the *Journal* and no longer contained summaries of papers. In 1924 the publication of abstracts became the province of the Bureau of Abstracts and ceased to be part of the *Journal*. Finally, in 1933 the *Journal* adopted that larger format which is familiar to-day. A most valued publication of the Society is the *Annual Reports on the Progress of Chemistry*, first published in 1905; and in the present year a new publication has commenced, namely, *Quarterly Reviews*.

Next to the reception of the publications of the Chemical Society, the most valued privilege of its fellows is the use of the library. In 1842 the secretary was empowered to obtain a bookcase. The Society received many periodicals in exchange for its own, but in 1850 the library consisted only of some 330 volumes and a hundred pamphlets. In 1855 the president, Dr. Williamson, directed the attention of fellows to the library "as a place of deposit for curious works upon chemistry". In 1860 Mr. Watts took charge of the library, and a Library Committee was first appointed in 1866. He was succeeded by Dr. L. T. Thorne in 1884, who was followed in 1894 by Mr. R. Steele. In 1903 Mr. F. W. Clifford, assistant librarian at University College, was appointed librarian, and held that office until his death in 1942. His kindly and efficient aid and his store of remarkable anecdotes will long be remembered by the present generation of British chemists. He was succeeded by Mr. A. E. Cummins, who had been assistant librarian since 1919.

By 1890 the library, exclusive of pamphlets, amounted to 9,884 volumes; during Mr. Clifford's tenure of office, it greatly expanded and became the finest chemical library in the world. The number of books to-day amounts to some 48,000, and their issue to fellows, which seems to have been customary from the first, is a most valuable service.

In 1853 it was decided to add "a little more life and general interest to the meetings by devoting up to five meetings a year to delivery of discourses on matters connected with the progress of Chemistry". A good many lectures were given, but only a small proportion of them were printed; however, as these lectures became fewer and at the same time more weighty, their publication became commoner. Five lectureships have since been founded, of which the oldest is the Faraday Lectureship, which is normally given every three years and originally had to be delivered by a 'foreigner or someone from a British Colony'. The first lecturer was Dumas; he was followed by Cannizzaro, Hofmann, Wurtz, Helmholtz and Mendeléeff. Since then, Rayleigh, Ostwald, Emil Fischer, Richards, Arrhenius, Millikan, Willstätter, Bohr, Debye, Rutherford and Langmuir have delivered the Faraday Lecture, and the eighteenth of these lectures is to be delivered on July 16 by Sir Robert Robinson on "The Development of Electrochemical Theories of the Course of Reactions of Carbon Compounds". Since 1918 four other lectureships have been founded, namely, the Hugo Müller, the Liversidge, the Pedler and the Tilden Lectureships.

The Society also gives a very practical and direct aid to research through its Research Fund, which expends an annual sum of about £7,000 in grants towards the expenses incurred by research workers.

The accomplishment of the Chemical Society is principally to be measured by the benefit that has accrued to its members' work from the amenities and facilities it has provided. We cannot estimate the intensity of this benefit, but we may form some notion of its extensiveness by considering the work that British chemists have done and are doing. A brief survey of such work must give a false impression, for it can offer no idea of the enormous volume of pieces of work, not always notable by themselves, but in the mass forming the solid structure of the science of chemistry. The principal impression that is given by a survey of British chemistry during the past century is the great increase in its volume and value after the year 1900. Not only was more work done, but also its importance relative to the work being done at the same time in other countries greatly increased. In the nineteenth century there were fine pieces of work, such as Graham's treatment of colloids, Roscoe's researches on vanadium and Perkin's syntheses of aromatic dyestuffs, but from the beginning of the twentieth century the contribution of British chemists rapidly increases. The remoter causes of this expansion are not altogether clear, but there was certainly a wave of opinion near the turn of the century which led to a more active encouragement of research at the universities of Britain, and especially at Oxford and Cambridge. Be this as it may, the facts are sufficiently impressive. Witness, for example, the discovery of the inert gases by Rayleigh, Ramsay and Travers, the elucidation of the phenomena of radioactivity by Rutherford and Soddy, the opening up of the great field of crystal chemistry by the Braggs, the epoch-making researches of Moseley. In the field of organic chemistry the electrochemical theory of the course of organic reactions is the fruit of British researches, especially those of Robinson, who has contributed so brilliantly to so many departments of organic chemistry. It would be invidious to single out one or two researches from the mass of brilliant organic work that to-day occupies the greater part of the *Journal of the Chemical Society*, but the work of present members of the Chemical Society upon the carbohydrates, the steroids, proteins, and other classes of organic compounds, is well enough known to all. The subject of chemical kinetics has been remarkably developed in Britain, in numerous centres, and is represented in the person of this year's president, Prof. C. N. Hinshelwood.

All this work has contributed to, and has been aided by, the great development of the British chemical industry, which, after a period of stagnation in the latter part of the nineteenth and early twentieth century, has been built up to a position second only to that of the United States. Never has British chemistry seen a more brilliant period than the present, and we may look forward with confidence to newer and greater conquests, both in our knowledge of things, and their utilization for the benefit of mankind.

TECHNIQUE OF X-RAY POWDER PHOTOGRAPHY*

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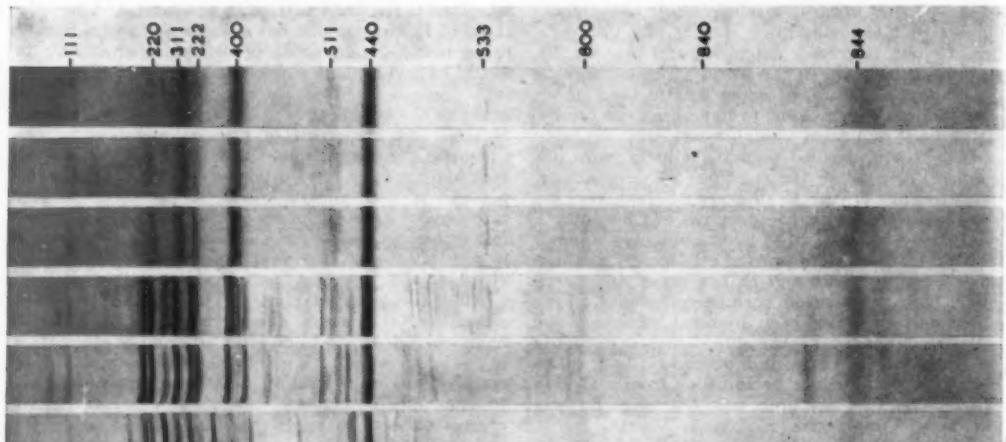
THE aspects of technique that influence the quality of the X-ray powder photograph can be classified into two groups: those concerned with the kind and purity of the X-radiation; and those concerned with the camera. A battery of X-ray tube target materials is desirable to give the necessary flexibility in the selection of wave-lengths. Demountable tubes in which targets are interchangeable, or sets in which sealed-off X-ray tubes containing different target elements can be quickly interchanged, provide alternative lines of approach.

In both schemes, some deterioration of the purity of the spectrum emitted by the tube has to be faced, though with the demountable set the provision of efficient evacuating equipment and regular cleaning of the target face minimize the difficulties. Nevertheless, it has to be recognized that a pure characteristic spectrum can only be maintained with certainty by the use of a crystal monochromator.

With Debye–Scherrer cameras mounted in the conventional position with respect to the X-ray tube target, line definition is primarily a function of specimen diameter and focal distance. There is a gain in resolution when the focal distance is lengthened by increasing the camera diameter. Cameras of maximum diameter of about 20 cm. have been adopted during the last few years; these are fitted with knife edges to provide reference shadows on the exposed negative. Accuracy of construction is essential to enable extrapolation methods to be applied for lattice parameter measurements[1]. Clarity of the powder photograph is improved by evacuation or hydrogen filling, and in some instances screening will help by the absorption of the secondary fluorescent radiation excited in the specimen.

* Abridgment of a lecture before the X-ray Analysis Group of the Institute of Physics delivered on April 22.



X-RAY POWDER PHOTOGRAPHS (COPPER $K\alpha$ RADIATION, 19-CM. CAMERA) OF VARIOUS FORMS OF ANHYDROUS ALUMINA

A small flat crystal monochromator suitable for use with circular cameras has been described by Lipson, Riley and Nelson[2]. Bent crystal monochromators, such as have been advocated by Guinier[3] and others, have the advantage of utilizing the energy of the X-ray beam much more economically. They suffer from the disadvantages that special cameras are required, and that they are really unsuited for the line focus X-ray tube in common use in Great Britain. Increased sensitivity in analytical problems results from the use of crystal-reflected rays, because of the elimination of the white radiation component of the X-ray beam and consequent reduction of background.

One of the chief purposes for which the powdered-crystal photograph is employed in industrial applications is for the specification and identification of crystalline phases. Besides problems concerning phase diagrams in metallurgy, X-ray methods are applied to the exploration of new reacting systems in the fields of inorganic and organic chemistry. An interesting example is provided by the series of X-ray photographs distinguishing the principal phases in the alumina-water system. Not only are six or more separate constituents found, but also the transformation between the two anhydrous forms, gamma and alpha, is significant both crystallographically and practically (see accompanying illustration).

The X-ray study of iron oxides is another example, as differences in colour of iron oxide pigment preparations are known to be related primarily to changes in the crystal forms of the hydrated and anhydrous oxides[4]. The brown colour of gamma ferric oxide is markedly different from that of red hæmatite. Although the X-ray patterns of black magnetite and gamma ferric oxide are remarkably similar, that of gamma ferric oxide shows superlattice lines as well as the displacements of the main lines associated with a smaller unit cell.

In the course of investigations of alumina/silica refractories, three forms of mullite have been distinguished by slight differences in their X-ray powder photographs[5]. The differences, which consist only of small relative displacements of high-order reflexions, are attributable to small changes in the unit cell dimensions. Some mullites of both natural and synthetic origin are found to contain up to 78 per cent of alumina compared with 72 per cent for the accepted composition with molecular formula $3Al_2O_3.2SiO_2$; yet the solid solution of the alumina effects but slight changes in the lattice parameters.

During the last few years, interest has been directed to structural anomalies or irregularities in certain substances. Powdered-crystal methods of investigation are applicable in many instances, provided the technique adopted gives sufficient clarity and resolution of the lines. In nickel oxide, for example, it has been shown that some reflexions are split into several components; there is a small distortion of the face-centred cubic structure, equivalent to a contraction along a [111] direction[6]. The nickel atom is slightly too small to allow the full cubic symmetry to be maintained.

Powder photographs of cobalt show exceptional effects, which are explained on the basis of mistakes in the stacking of the close-packed layers of cobalt ions[7]. Extra reflexions on X-ray photographs of graphite have been noted for some years[8]. They are real and not spurious lines attributable to the use of impure radiation, because they occur if the radiation is monochromatized by crystal reflexion. They cannot be accounted for by the hitherto accepted hexagonal structure, but are explained if it is assumed that in powdered graphites there is present a second closely related structure with one and a half times the cell height[9]. With most graphites, too, the X-ray powder lines show varying degrees of sharpness, attributable to imperfections in the stacking of the hexagonal nets of carbon atoms.

The significance of crystal structure in relation to physical properties such as refractive index, permittivity or piezo-electricity is becoming increasingly apparent. Polymorphic transformations with temperature such as those observed by Ubbelohde[10] and

his colleagues in potassium dihydrogen phosphate and in barium titanate by Megaw[11] are examples. Although the work on potassium dihydrogen phosphate was carried out by single-crystal methods, studies of barium titanate and like compounds have been made by powdered-crystal technique. Such investigations require X-ray examinations at elevated and at sub-normal temperatures. There is obvious need for the provision of precision instruments for high- and low-temperature powder photography.

Concerning future prospects, emphasis must be placed on further developments and improvements in technique and instrumentation. Although the Geiger counter spectrometer may become extremely valuable, particularly in industrial research, the photographic film will no doubt continue to form the backbone of the powdered-crystal method for a long time to come. Much can be achieved by attention to detail and by the proper design of X-ray generators and cameras. Cameras, for example, should be such that they can be handled by any intelligent laboratory assistant, so that the X-ray crystallographer is free to devote his full energies to planning experiments and interpreting results. The work on the design of equipment being undertaken by the X-ray Analysis Group of the Institute of Physics should result in the early achievement of this ideal.

[1] Nelson, J. B., and Riley, D. P., *Proc. Phys. Soc.*, **57**, 160 (1945).
[2] Lipson, H., Riley, D. P., and Nelson, J. B., *J. Sci. Instr.*, **22**, 184 (1945).
[3] Guinier, A., *Proc. Phys. Soc.*, **57**, 310 (1945).
[4] Bunn, C. W., *J. Sci. Instr.*, **18**, 70 (1941).
[5] Rooksby, H. P., and Partridge, J. H., *J. Soc. Glass Tech.*, **23**, 338 (1939).
[6] Rooksby, H. P., *Nature*, **152**, 304 (1942).
[7] Edwards, O. S., and Lipson, H., *Proc. Roy. Soc.*, A, **180**, 268 (1942).
[8] Rooksby, H. P., and Steward, E., *Nature*, **159**, 638 (1947).
[9] Lipson, H., and Stokes, A. R., *Proc. Roy. Soc.*, A, **181**, 101 (1942).
[10] Ubbelohde, A. R., and Woodward, I., *Proc. Roy. Soc.*, A, **188**, 291 (1947).
[11] Megaw, H. D., *Trans. Farad. Soc.*, **46**A, 224 (1946).

HERMAPHRODITISM IN THE LOWER VERTEBRATES

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BY the publication in 1944 of a description of the gonads of *Monopterus javanensis* Lac. (Symbranchii ; Teleostei), Liu[1] has furnished new and interesting evidence concerning the mechanism of sex determination in the lower vertebrates, and has opened a fresh field for research into this subject. It is well known that, while the separate nature of the sexes is a general rule among fishes and amphibians, there are many species in which this separation is neither stable nor complete, and a great deal of research, both descriptive and experimental, has been devoted to the problem. In these circumstances it is exceptionally interesting to find that *Monopterus* is peculiar—and so far apparently unique—among vertebrates in being a true hermaphrodite, which functions as a female during the first half of its life and as a male during the second. It appears that this discovery may be one of considerable theoretical significance, and in order to place it into its proper context, the present state of our knowledge concerning sex determination in the lower vertebrates may be briefly summarized.

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Vertebrate Sex Determination

The outlines of this problem were first defined by observation and description. It has become evident that while the primordial germ cells of the male and female are strictly homologous, those which are to form ova come to lie in the cortex of the rudimentary gonad, whereas those which are to form spermatozoa come to lie in the medulla. In many fishes and amphibians, the so-called 'undifferentiated races', it has been found normal for the cortical cells to develop first, with the result that all immature individuals pass through a female stage when their gonads contain oocytes. At this time genetical males cannot be distinguished from genetical females. The phenomenon has been particularly closely studied in amphibians, and has been reviewed in detail by Witschi[2,3]. Complementary to it is the observation, made on both fishes (Bullough[4]) and amphibians (Crew)[5], that older females commonly become transformed into males. It follows that in these species the basic difference between the sexes is not absolute, but lies merely in the duration of the female stage. In the male this stage is passed in immaturity, while in the female it lasts until almost the end of life. It is further evident that animals of this type occupy an intermediate position between a typical hermaphrodite and a typical gonochorist, and that they may illustrate an important evolutionary step.

Here a caution is probably needed that such normal sex reversals as those described above must be clearly distinguished from the many abnormal cases of intersexuality which have been reported in lower vertebrates (Bullough[6]), and which are presumably due to some individual maladjustment in the mechanism of sex determination or in the endocrine balance. Further, the peculiar condition of the Mediterranean teleosts *Serranus* and *Sargus*, in which ova and spermatozoa are ripened simultaneously (van Oordt[7]), is probably to be regarded as a unique specialization of the common mechanism.

The experimental work which has been performed on the problem of sex determination has been extensive and has so far produced the following main generalizations (Witschi[2,3]). The sex, or *X*-, chromosomes constitute the female-determining force called *F*, while the rest of the chromosome complex, the autosomes, are the male-determining force called *M*. In some invertebrates, such as *Bonellia*, the diploid condition might be designated by the letters *MMFF*, with the strength of *M* being approximately equal to that of *F*. In these circumstances the environmental conditions determine which sex shall be dominant. In the 'undifferentiated races' of amphibians, the sexes have come to be determined by the fact that one of the female chromosomes, the *Y*-chromosome, has a weaker effect than the other. Its reduced strength is termed *f*. In these circumstances a female has the constitution *MMFF*, where *F* is more powerful than *M* ; whereas a male has the constitution *MMFf*, where *M* + *M* is more powerful than *F* + the weaker *f*. However, the balance is still such that it can be upset by abnormal environmental conditions, as, for example, by a high temperature. Finally, in a typical gonochorist, the state is reached where the power of the *Y*-chromosome is nil. A female then has the constitution *MMFF* and a male *MMF*, and in these circumstances sex is relatively stable from the earliest stage of development.

The mode of action of these sex-determining forces is through a stimulation of inductor production within the indifferent gonad. The nature of the inductors is not yet understood, but they are known to diffuse from cell to cell and are presumed to be of a protein nature. The female inductor is called 'corticin', the male inductor is 'medullarin', and they are, of course, strongly antagonistic. It must be emphasized that they are not to be confused with the sex hormones of older animals. In the 'undifferentiated races' œstrogenic hormones can induce immature genetical males to develop into females just as androgenic hormones can induce immature genetical females to become males (Witschi[8]); but these effects would appear to be entirely artificial.

Research on the 'undifferentiated races' has also led to the further important conclusion that in these animals the chromosome balance between MM on one hand and FF or Ff on the other is not constant, but varies with age. This is the explanation of the fact that a male develops first as a female, since the influence of $F + f$ is felt before that of $M + M$. When the full power of $M + M$ is felt, the direction of development changes and the animal becomes transformed into a male. It is unfortunate that little or no experimental work has yet been done on the mechanism involved in the change of older females into males. It might be guessed that the nature of this change may be similar to that in young males, except that the sex hormones may play a significant part. Its basis may be that the relative power of $M + M$ finally rises to dominate that of $F + F$, either by an actual change in the powers of the chromosomes or by a change with age in the response of the gonads to them.

Hermaphroditism of *Monopterus*

The discovery of the condition of *Monopterus javanensis* makes the experimental study of adult sex changes even more urgently necessary, and because of the inaccessibility of the original paper, a restatement of the results already announced regarding this species may be of value. The fish itself is widespread in the rice fields of China, the Malay Archipelago, and the East Indies. It has an eel-like form, it is capable of breathing air, and it reaches a length of some 60 cm. Most of the 659 specimens on which the work is based were obtained from the market at various times throughout the year, and they were reported to have been caught in the rice fields of Pehpei and Hockwan in Swechwan, China. No secondary sexual characters can be identified in this species, and the sexes were therefore distinguished by the superficial appearance of the gonads. The intersexes were not at first recognized, and since they still possessed eggs they were classed as females. Consequently, with the accompanying table, the warning is given that the figures for females "possibly include a small number of intersexes". In this table, since age could not easily be determined, the state of the gonads is related to body-length.

The fish of the first three length-groups, referred to as fingerlings, were immature, but they were clearly recognizable as females. The next groups contained young adults which were also almost entirely female, and many of which contained fully developed eggs ready to be shed. The normal 1 : 1 sex ratio was found only in the narrow length-range of 36·0–37·9 cm. Of the 300 adult fish below this range, 270 (90 per cent) were females, while of the 210 fish above it,

FREQUENCY OF MALE AND FEMALE INDIVIDUALS IN DIFFERENT RANGES OF BODY-LENGTH

Class range in cm.	Male		Female		Total number
	Numbers	Per-centage	Numbers	Per-centage	
5·0–6·9	0	0	18	100·0	18
7·0–8·9	0	0	58	100·0	58
9·0–10·9	0	0	9	100·0	9
22·0–23·9	1	20·0	4	80·0	5
24·0–25·9	0	0	8	100·0	8
26·0–27·9	1	3·3	30	96·7	31
28·0–29·9	3	6·7	42	93·3	45
30·0–31·9	6	8·8	62	91·2	68
32·0–33·9	7	10·3	61	89·7	68
34·0–35·9	12	16·0	63	84·0	75
36·0–37·9	35	54·7	29	45·3	64
38·0–39·9	32	65·3	17	34·7	49
40·0–41·9	32	94·1	2	5·9	34
42·0–43·9	28	93·3	2	6·7	30
44·0–45·9	31	96·9	1	3·1	32
46·0–47·9	16	94·1	1	5·9	17
48·0–49·9	17	94·5	1	5·5	18
50·0–51·9	8	88·9	1	11·1	9
52·0–53·9	11	100·0	0	0	11
54·0–55·9	7	100·0	0	0	7
56·0–57·9	3	100·0	0	0	3

185 (88 per cent) were males. It can only be concluded that all individuals commence life as females and breed as such before becoming transformed into males. In other words, "male and female in this fish are not distinct categories, but are merely temporary phases in the life of the same individual". For the greater part of the population the change in sex is accomplished between the body-lengths of 34 cm. and 40 cm., but occasional exceptions occur. Thus one specimen of only 23 cm. body-length was found to have completed a precocious change, while two others of 48 cm. and 50 cm. body-lengths respectively were still true females. These last two fish were obtained from a pond which was unusual in that it never dried up, and that it contained an abundant food supply. It is therefore suggested that such exceptions may be the result of abnormal living conditions, and particularly of abnormal nutrition.

The histological details of the gonad transformation have not yet been closely studied by Liu; but the following short account can be given now. The ovary is bounded by a thick connective tissue tunica, from the dorsal side of which two long connective tissue folds hang into the ovary cavity. The cavity enclosed by each of these folds is empty, while the cavity between and around the two folds contains the oocytes. During the change of sex, testicular tissue arises within the walls of the connective tissue folds, and simultaneously the oocytes begin to disintegrate, the largest being affected first. By the time the testicular tissue is fully developed, the oocytes have entirely disappeared.

Conclusions

It will be evident that these observations on *Monopterus* agree well with those already made on the various 'undifferentiated races' of the lower vertebrates. In the first place, *Monopterus* shows the normal juvenile female phase, and in the second the sex-change is in the normal direction of female to male. Indeed, the only difference between it and the other fish and amphibians mentioned above is one of degree. In *Monopterus* all individuals change their sex at about the same age, while in the others half (the males) make the change early, and half (the females) make it late or not at all. However, this difference is of considerable theoretical interest, and it is important that an attempt should be made to discover whether the hermaphrodite condition of *Monopterus* is primitive or specialized.

The evidence available from the study of the various 'undifferentiated races' can be held to support a theory that some, if not all, of the members of the old vertebrate stock were protogynous hermaphrodites, and that only afterwards were separate sexes established by the evolution of a chromosome mechanism which caused a progressively earlier sex change in the forming males and a progressively later one in the forming females. Thus *Monopterus* may be to-day in a condition similar to that of the earliest vertebrates. Unfortunately for this theory, the primitive nature of any of the features of *Monopterus* cannot be lightly assumed. It belongs to an aberrant order, the Symbranchii, the affinities of which have not yet been fully settled, and it may well be that the mechanism of its sex reversal is as specialized as is its bodily structure. One test which might be applied is to search for some trace of a *Y*-chromosome. If the hermaphrodite condition is primitive, this chromosome may be lacking; but if it is secondary, it may still be distinguishable by its shape. It is clearly a matter of great interest that further and more detailed research should be carried out on this unusual fish, and also that a search for similar conditions should be made in the other members of the order Symbranchii.

[1] Liu, C. K., *Sinensia*, **15**, 1 (1944).
[2] Witschi, E., Chapter 5 of "Sex and Internal Secretions" (London, 1932).
[3] Witschi, E., Chapter 4 of the 2nd edition of "Sex and Internal Secretions" (Baltimore, 1939).
[4] Bullough, W. S., *J. Exp. Zool.*, **85**, 475 (1940).
[5] Crew, F. A. E., *J. Genet.*, **11**, 141 (1921).
[6] Bullough, W. S., *Proc. Leeds Phil. Soc.*, **3**, 638 (1939).
[7] van Oordt, G. J., *Z. mikr. anat. Forsch.*, **19**, 1 (1929).
[8] Witschi, E., Cold Spring Harbor Symp. Quant. Biol., **10**, 145 (1942).

OBITUARIES

Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S.

WITH the unexpected death of Sir Thomas Henry Holland, on May 15, British geology in general and Indian geology in particular has lost its most illustrious figure, one whose outstanding position was recognized by the fact that he was president designate of the Eighteenth Session of the International Geological Congress to be held in Great Britain in 1948, and was also president of the Organising Committee of this Congress.

Thomas Henry Holland was born on November 22, 1868, at Helston, Cornwall, and was the son of John Holland, of Springfield, Manitoba, Canada, and Grace Treloar Roberts.

He was educated at a small dame's school at Helston, and when only sixteen won a National Scholarship to the Royal College of Science, London, where he took a first class associateship in geology with honours, in 1888, winning also the Murchison Medal and Prize. After a period at South Kensington as assistant to Prof. Judd, he gained a Berkeley Fellowship to Owens College, Manchester, in 1889. In 1890, at the age of twenty-one, he was appointed an assistant superintendent in the Geological Survey of India. He did not, however, proceed direct to his appointment, but travelled to India via the United States, Canada and the Far East, his service dating from his arrival in Calcutta in October 1890, when he was made curator of the Geological Museum and Laboratory. In addition, he became the part-time lecturer in geology at Presidency College, Calcutta, where (there being then no professorship in geology) he organised the courses in geology and established securely the custom that prevailed for many years by which the curator of the Geological Survey of India usually also lectured at Presidency College. While curator, Holland effected many improvements in the arrangement of the Mineral Gallery of the Museum, continuing the work begun by F. R. Mallet. In particular, he assembled and arranged typical collections of the pre-Cambrian (including Archæan) formations of India.

Although, by holding the post of curator for some years, Holland was nominally stationed at headquarters in Calcutta, he made repeated excursions into the field, and was also available to the director of the Geological Survey for emergency inquiries as they arose. He thus soon established for himself a reputation as a petrographer, and as one interested in the economic side of geology; that he was a man of energy and organising ability the Government of India soon became aware.

Throughout its history, the Geological Survey had devoted a considerable part of its energies to the mapping and study of the Indian coalfields, and had also recently had a specialist (F. H. Hatch) at work on certain gold deposits. Yet on the whole the department was then, in the view of the Government of India, giving too much attention to the theoretical side of geology and too little to the practical side. The consequence was that in February 1903 Holland was appointed director in succession to C. L. Griesbach, who was retiring on superannuation. This meant the supersession of several geologists senior to Holland, some of them (for example, R. D. Oldham, C. S. Middlemiss and T. D. La Touche) of first-class quality. After the initial shock, however, they collaborated loyally with the young new director (Oldham retiring two years later), and Holland set to work to reorganise the work of the department and to raise its status, both with Government and with the business public. He secured from the Government of India an increase of staff and better terms of pay, and detailed some of his officers to make comprehensive studies, scientific and economic, of particular minerals (for example, coal, manganese ore, and petroleum) on the lines he had already set for mica before his promotion.

In addition, Holland secured the transfer from the Revenue and Agriculture Department of the Government of India to the Geological Survey the duty of collecting and collating the statistics of mineral production of India, in annual reviews published in the *Records of the Geological Survey of India*, which he resuscitated after their suppression by his predecessor. Further, he instituted the well-known quinquennial reviews of mineral production, the first one actually covering a six-year period, 1898–1903. These quinquennial reviews are not mere assemblages of the annual figures. They contain, also, geological and economic data, covering each mineral, that are not in the annual reviews; and they were, until 1933, a special feature of the *Records* of the Indian Geological Survey that had no parallel among the publications of any other geological survey in the world.

Holland also secured the transfer to the Geological Survey of the duty of advising the Central and Provincial Governments concerning the terms of the grant of mineral concessions throughout British India, the existing rules being still based on the rules

as revised by him. He was also president (1908) of the Burma Oil Reserves Committee, which drew up the rules for the regulation of the Burma oilfields with the object of preventing their wasting competitive exploitation by rival companies.

In spite of the great number of administrative improvements effected by Holland, he was director of the Geological Survey only until 1909, when he accepted an invitation to the chair of geology of the University of Manchester. One of the reasons for his early retirement from India was his disappointment that the Government of India had not implemented in full his scheme for the increase of staff and scales of pay of his department. However, Holland's outstanding services to science in India were recognized by the award of the K.C.I.E. in 1908.

It is not too much to say that as a result of Holland's directorship the Geological Survey of India was permanently faulted up, to use a geological simile, into a position of prestige in India, both with Government and with the public, from which it has never fallen back. His successor, Sir Henry Hayden, for example, quite early secured the increased cadre and scales of pay for which Holland had fought.

Sir Thomas, as he had now become, was, however, destined to return to India; in 1916 he was appointed chairman of the Indian Industrial Commission, the report of which may be taken as a basis of the Government of India's help in the modern industrial development of India. The knowledge of Indian industries obtained during its investigations led to the whole Industrial Commission being converted, also in 1916, into the Indian Munitions Board, with Holland as president; and all who had the privilege of working under Holland in this Board know the skill and energy with which he built up the giant organisation that kept the Indian armies, wherever employed, supplied with all the varied munitions and stores required for modern warfare. It is fair to say that three men, the Commander-in-Chief, the Finance Member to the Government of India, and the President of the Board of Munitions, were the principal organisers and directors of India's military effort in the First World War. For his share in this Sir Thomas was created K.C.S.I. in 1918. When the War ended, the Indian Munitions Board became, in 1919, the Department of Munitions and Industries, Holland thus becoming a member of the Viceroy's Executive Council. In 1921 he was also appointed Member for Commerce, so that he held two portfolios simultaneously. At the end of 1921 a difference with the Viceroy (Lord Reading) on the withdrawal of a munitions prosecution in Calcutta led to Holland's resignation; but the sympathies of all who knew the inner facts were with Sir Thomas Holland.

This check in Holland's career was but of brief duration. In 1922 he succeeded Sir Alfred Keogh as rector of the Imperial College of Science and Technology, London; and his success as an educational administrator in this post led to his appointment in 1929 as principal and vice-chancellor of the University of Edinburgh in succession to Sir Alfred Ewing. In spite of his dictum that seven years in one appointment was sufficient, Sir Thomas held the Edinburgh office for fifteen years, retiring in 1944 at the age of seventy-six with the title of emeritus principal and vice-chancellor of the University.

It must also be recorded that after retiring from the Geological Survey of India, Sir Thomas retained his interest in oil problems. Thus, he was a member of the Royal Commission on Navy Fuel, 1911–13. In 1928 he visited Trinidad and reported to the Colonial Office on policy in promoting the maximum and most efficient exploitation of the Island's oil resources. He was for many years geological consultant to the Burmah Oil Company and for nearly twelve years a member of the geological advisory board of the Anglo-Iranian Oil Company.

Although Holland was thus almost continuously in harness for fifty-four years, his outstanding energy and organising ability led naturally to his taking also a prominent part in the administration of scientific and technical societies and institutions. He commenced by founding in 1906 (with the late W. H. Pickering, chief inspector of mines in India) the Mining and Geological Institute of India, of which he became the first president. He was chairman of the trustees of the Indian Museum, Calcutta, 1906–9, and in 1909 he was president of the Asiatic Society of Bengal (now the Royal Asiatic Society of Bengal). In 1915–16 he was president of the Institution of Mining Engineers, London. Later, he was president of the Institution of Mining and Metallurgy, and of the Institution of Petroleum Technologists, and chairman of the Royal Society of Arts, all at the same time (1925–27). During 1927–30 Holland was chairman of the Empire Congress of Mining and Metallurgical Institutions, and in 1933–34 he was president of the Geological Society of London and in 1933–36 of the Mineralogical Society. He also served the British Association as a sectional president (geology, 1914, and education, 1926) and was president of the Association at its meeting in South Africa in 1929. He was a vice-president of the Royal Society in 1924–25.

On his retirement from Edinburgh in 1944, Sir Thomas returned to London with vigour of mind and body unimpaired, and resumed his practical interest in the administration of learned and technical societies. He rejoined the Council of the Institution of Mining and Metallurgy as a past-president, and became foreign secretary to both the Geological Society and the Mineralogical Society, his seniority and personal friendship with many geologists and mineralogists abroad making him peculiarly suitable for such work. Further, as already mentioned, he was to be president of next year's International Geological Congress.

It was inevitable that a man of such outstanding ability and energy should be the recipient of many honours in addition to the awards of K.C.I.E. and K.C.S.I. already mentioned. In addition to honorary degrees from many universities he received the Bigsby Medal of the Geological Society of London (1913), the Albert Medal (1939) of the Royal Society of Arts, and was an honorary fellow of the Royal Asiatic Society of Bengal.

Although Holland, from the time of his promotion to the directorship of the Geological Survey of India at the very early age of thirty-four, devoted his energies and abilities mainly to scientific and educational administration, yet he had already to his credit a considerable volume of first-class research, mainly on the petrographical (and chemical) side of geology; this was recognized by his election to the Royal Society in 1904. His published papers include five *Memoirs*, of which one is on the charnockite series (1900), another deals with his discovery of elæolite-syenites in India (the Sivamalai series, 1901), and a third is a comprehensive work on the mica deposits of India (1902), dealing with both the scientific and economic aspects of a mineral of which

India is the world's chief source of supply. Many of his papers in the *Records of the Geological Survey of India* also deal with petrographical problems, of which the most noteworthy are perhaps those on the mica-apatite–peridotite intrusions in the Bengal coalfields (1894) and on the origin and growth of garnets (1896). Holland also recognized early the essential identity of bauxite and laterite (*Geol. Mag.*, 1903). One of Holland's earliest papers, that on the Gohna landslip, Garhwal (*Records, Geol. Sur. India*, **27**; 1894), recorded work that created a sensation with the Indian public. A landslip had thrown a dam across a Himalayan valley and created a large lake where there had been none before. Holland, who was sent to investigate, gave a middle date for the breaching of the dam and the depth to which it would be cut down when this happened. He also recommended the evacuation of the population endangered by the prospective floods some time in advance of his date. This was done, and the dam was breached on almost the exact date predicted. Holland also gave valuable advice in connexion with landslips in the hill stations of Naini Tal and Darjeeling.

The research for which Holland is best known to science is that described in his *Memoir* (**28**, Pt. 2, 1900) on the charnockite series, in which he described a peculiar series of granulitic rocks ranging in composition from acid to ultrabasic and forming an important part of the Archæan terrain of the Madras Presidency. The common denominator in these rocks is the presence of hypersthene; and for the type rock, a hypersthene-granite, Holland selected the name 'charnockite' after Job Charnock, the founder of Calcutta. Charnock's tomb is in St. John's Churchyard, Calcutta, and, as Holland discovered, is fashioned out of a block of hypersthene-granite brought from Madras. In Holland's view, all the members of his charnockite series are consanguineous and form a petrographic province of genetically related plutonic igneous rocks. Similar rocks have been found since in other countries, for example, Antarctica, West Africa and Uganda, and their origin has for many years been a matter of controversy. Whatever may be the final verdict on the origin of this interesting suite, there can be no doubt as to the importance of Holland's work thereon, and of the stimulus it imparted in many countries to the study of their hypersthenic rocks, and in India to that of the Archæan terrain in general.

Whatever Holland wrote, whether in official correspondence, or for publication, was precise and clear, and often trenchant. His presidential addresses to learned and technical societies never went into details, but always dealt with broad outlines, so that they were of widespread interest. In his earliest such address (that to the Mining and Geological Institute of India in 1906) he proposed a new scheme for classifying the geological formations of India, holding that the main divisions suitable for Europe, where stratigraphical nomenclature originated, were not suitable for Gondwanaland with its very different geological history. Thus came to be introduced the terms 'Aryan', 'Dravidian' and 'Purana', with Archæan at the base, for the larger subdivisions of the geological column in India. This interest in stratigraphical nomenclature caused Sir Thomas after his first retirement from India to write his "Indian Geological Terminology" (*Mem., Geol. Sur. India*, **43**, Pt. 1; 1913), in which he was helped by the late Mr. G. H. Tipper (see *Nature*, June 21, p. 834), and of which a second edition appeared in 1926.

In his first address as president of the Geological Society of London (1933), Sir Thomas discussed "The Geological Age of the Glacial Horizon at the Base of the Gondwana Systems", showing that this horizon is one of the most important datum lines of the geological column. In his second address (1934) he took as his theme the ideal composition and minimum strength of a geological survey department if it was to be fully efficient. This address has been, and is likely in the future to be, of great use to directors trying to convince their Governments of the needs of their departments. In his address as president of the Geological Section of the British Association in Australia in 1914, Sir Thomas reviewed recent advances in developing theoretical conceptions regarding the interior of the earth that are of direct importance to geologists. In his address as president of the Association at Johannesburg in 1929 he discussed "The International Relationship of Minerals". Sir Thomas was greatly interested in the impact of the economics of mineral deposits upon national and international affairs, as was shown by this and other addresses, and as was summarized in a small book entitled "The Mineral Sanction as an Aid to International Security" (Oliver and Boyd, 1935), in which he showed, before the recent War, that if the British Commonwealth, the United States of America and the U.S.S.R. were to adopt a common policy on the export of minerals of use for munitions purposes to potentially aggressor countries, such as Germany and Japan, the outbreak of war could be prevented.

As will be judged from the foregoing, Sir Thomas Holland was a man of outstanding ability and energy. His worship of efficiency meant that he could not suffer fools, and that in his official relations his reactions to his colleagues and subordinates were mainly determined by his desire for efficiency, with handsome recognition of good work. But in private life Holland could be a delightful companion, especially as he was a good *raconteur* with an endless fund of amusing stories.

Holland married first, in 1896, Frances Maud (who died in June 1942), daughter of the late Charles Chapman, Deputy Commissioner in Oudh, and by this marriage he had one son (now Major-General John F. C. Holland) and one daughter (Margaretta, widow of Col. A. G. Shea); and secondly, in 1946, Helen E. Verrall, of Bramley, near Guildford.

L. L. Fermor

Prof. F. Pavlíček

Prof. František Pavlíček, who died on January 4 at the age of seventy-two, was one of Brauner's earlier pupils. Brauner and Pavlíček undertook in 1900 the revision of the atomic weight of lanthanum, and their results were eventually published in the *Transactions of the Chemical Society* in a lengthy paper. The figure they obtained, 139·04, is still accepted. Most of Pavlíček's later work was connected with mineralogy, fuel technology and thermochemistry, since he held appointments first at a technical college in Brno and later at the Přibram School of Mines in South-West Bohemia. These investigations, mostly published in Czech, relate to the calorific values of various coals (including local lignites) and the utilization of coal gas, industrial gases and coke in metallurgy. Prof. Pavlíček also wrote, in 1927 and 1931, the standard Czech work on the chemistry of coal. J. G. F. Druce

NEWS and VIEWS

Chemistry in London

THE Chemical Society, the centenary of which fell in 1941, is celebrating the occasion during July 15–17 (see p. 6 of this issue) by a series of meetings in London. Whereas only two overseas countries, France and Germany, sent representatives to the jubilee meetings, some twenty different countries will be represented. Among the bodies represented will be the Australian Chemical Institute, the Chemical Institute of Canada, the New Zealand Institute of Chemistry and the South African Chemical Institute. The Irish Chemical Association is sending its president, Dr. Vincent Barry. India will be represented by a distinguished delegation including Sir Shanti Bhatnagar, Sir J. C. Ghosh and Dr. Venkataraman. Other Commonwealth local representatives who will be present are Dr. T. Iredale (Australia), Prof. W. D. McFarlane (Canada), Prof. W. Pugh (South Africa) and Prof. T. S. Wheeler (Eire).

France will be represented by Prof. R. Delaby, president, and Dr. G. Champetier, secretary, of the Société Chimique de France, and by a representative of the Société de Chimie Industrielle. The Société Chimique de Belgique will send Prof. J. Timmermans. Dr. H. Jørgensen will be the official representative of the Kemisk Forening, Copenhagen, and will be accompanied by Profs. Niels Bohr, N. Bjerrum and N. J. Brønsted. Profs. G. de Hevesy and H. Erdtman will represent the Royal Swedish Academy of Sciences and the Swedish Chemical Society. Prof. E. Berner, president of the Norwegian Chemical Society, will represent Norway. Prof. D. Marotta will represent the Societa Chimica Italiana. Prof. Paul Karrer will be the official representative of the Swiss Chemical Society, and he will be accompanied by Prof. L. Ruzicka. A very strong delegation will come from the great sister organisation, the largest chemical society in the world, namely, the American Chemical Society, the official delegates of which will be the president, Dr. W. A. Noyes, jun., president-elect, Dr. C. A. Thomas, and secretary, Mr. A. H. Emery. Other Americans present will be Colonel Marston T. Bogert and Prof. Linus Pauling. China will be represented by Prof. Edith Chu.

Following on the Chemical Society celebrations, there will be the eleventh International Congress of Pure and Applied Chemistry, which is being held chiefly at the Imperial College of Science and Technology, South Kensington, during July 17–24, and concurrently, meetings of the International Union of Chemistry in the apartments of the Royal Society. Lord Leverhulme is president of the Congress, which is meeting in fourteen sections, one of them being a new one formed at the request of France to discuss chemistry in relation to essential oils, flavouring materials and cosmetics. It is expected that some two thousand chemists from at least twenty-four different countries will attend. The opening ceremony by the president of the Congress and the closing session, consisting of a lecture by Sir Robert Robinson, president of the Royal Society, will be at the Central Hall, Westminster, and all other sessions at the Imperial College of Science and Technology, South Kensington. The last International Congress of Pure and Applied Chemistry, which normally is held every four years, was in Rome in 1938; the only previous one to be held in London was in 1909. The first was in Brussels in 1894.

Chemistry in Glasgow: Opening of the Henderson Laboratory

AT a short ceremony held in the Chemistry Department of the University of Glasgow on the afternoon of June 25, Sir Robert Robinson named the new Henderson Laboratory. This Laboratory had been occupied by the Admiralty during the War; and the University's share in the cost of its re-equipment to provide up-to-date accommodation for sixteen graduate research workers in organic chemistry has been partly met from a fund raised in memory of Henderson's work both at the Royal Technical College (1892–1919) and at the University (1919–37). Prof. J. W. Cook paid tribute to Henderson on behalf of the University and Prof. W. M. Cumming on behalf of the Royal Technical College. Dr. J. W. McDavid (chairman of the Explosives Division of Imperial Chemical Industries) moved a vote of thanks to Sir Robert Robinson. Sir John Boyd Orr, the newly installed chancellor of the University, was present, as was also the principal, Sir Hector Hetherington. Earlier in the day the University had conferred upon Sir Robert Robinson the honorary degree of LL.D.

Zoology at Birmingham: Prof. P. B. Medawar

MR. P. B. MEDAWAR, fellow of Magdalen College, University demonstrator and lecturer in the Department of Zoology and Comparative Anatomy, Oxford, has been elected to the chair of zoology in the University of Birmingham. Not yet thirty-three, he has had a brilliant career at Oxford, winning a Christopher Welch Research Scholarship in 1935, the Edward Chapman Research Prize in 1938, and the Rolleston Memorial Prize in 1942. While his outlook is physiological and experimental, he has a true regard for the discipline of comparative anatomy which will ensure that his school will be well balanced and built upon a sound foundation. It is relevant to recall what he wrote in an article on zoology at Oxford in *Biology* in 1944: "It is indeed not comparative anatomy, but the *method* of comparative anatomy, that makes the substance of Oxford's tradition of zoology. Comparative anatomy is only part of zoology, but the method devised for its analysis is the method of all creative science in its most difficult, fallible, and in a sense most sophisticated form. In comparative anatomy, the object is not to examine diverse animal forms, which is easy, but to appraise the significance of their diversity. . . . If it has ever been said that a man trained in the methods of comparative anatomy should be able to turn his hand to most things, the variety of Oxford's useful researches in zoology does nothing to belie the judgment."

Prof. Medawar himself has a great variety of zoological interests, and his research lies along two very different lines. In one he is developing the mathematical treatment of animal form and the process of growth and ageing; in this he carries forward the pioneer work of Sir D'Arcy Thompson. His second main interest is a study of the differences between individuals. Here come his valuable researches on mammalian skin grafting, so important in their human application; his approach to the problem is both immunological and genetical. A recent development has been his discovery and investigation of the curious phenomenon of an induced spread of pigmentation when pieces of black skin are grafted into white areas of a piebald guinea-

pig. Prof. Medawar has a fertile imagination combined with an ability for putting his ideas for research into practice. We look forward with confidence to the development of his Birmingham school of zoology.

František Křižík (1847–1941)

ALTHOUGH he died in occupied Prague as recently as 1941, Křižík's centenary falls this year. Born of poor parents on July 8, 1847, he was as much a man of science as an engineer. His aim in life was neither riches nor fame, but he had a constant desire to invent, to improve and to lessen the drudgery of manual labour. Obviously he had to seek a career in electrical engineering, and as a youth he attracted attention by installing a satisfactory telegraph system on the various private Central European railways that were then being constructed. As a railway engineer Křižík had plenty of scope for his inventive talent, and in 1878 he introduced a block signal system designed to prevent accidents. In 1880 he produced an electric arc lamp that gave better and more constant illumination. In the following year, opportunity was taken to show the lamp at the Paris Exhibition, where it gained first prize. Gold medals were also awarded for it at the Munich and Vienna Exhibitions of 1883, and these lamps were soon being made in Britain and used for lighting the streets of London, Paris and elsewhere. Křižík now gave up his railway appointment at Pilsen and established an electro-technical works at Prague for making not only lamps, but also dynamos and other electrical apparatus and machines. He experimented with an electrically driven train as early as 1891, the year of the Prague Exhibition, for which he was both architect and engineer. His illuminated fountain and electric railway (the precursor of many European tramways) provoked wide comment and largely contributed to the success of the exhibition.

No less than a hundred and thirty electrical power stations were constructed by Křižík, who was all the time studying electro-technical theory and applying it to problems of transport, lighting and other needs. He was critical of academic instruction in physics; for in his student days at the Prague Technical University, the whole of electro-technics was dismissed in two lectures as part of the course in electricity. In his later years he was engrossed in the expansion of his works, but was certainly active and interested in the progress of science at the time of his ninetieth anniversary. He died in the midst of the Second World War on January 22, 1941, at a time when it was impossible to pay tribute to his achievements.

British Scientific Instrument Research Association: New Laboratories

THE formal opening of the new laboratories of the British Scientific Instrument Research Association will take place on Thursday, July 10 (not July 9 as previously announced). The Minister of Supply will be the principal guest. The address of the laboratories is "Sira", Southill, Elmstead Woods, Chislehurst, Kent (Imperial 2237). Recent issues of the monthly *Bulletin* of the Association have reported on the progress made in transferring the Association's laboratories from Russell Square, London, to "Sira". The Chemical Department occupies the first floor of the new buildings, with a large main laboratory, two research laboratories, a balance room, a preparation room and ample storage space. There is also a furnace room, equipped with glass-making crucibles, away from the main building. The transfer of the Physics Department was begun last December, and it will occupy two large laboratories, a dark room and an office, all situated on the ground floor. One laboratory is equipped as a high-vacuum laboratory, with three different types of evaporation plants (Hickman, Edwards and Metro-Vickers). This section has been largely concerned in the past with the problems of production of aluminium, rhodium and anti-reflexion evaporated films. Efforts are now being directed to the production of three types of interference films: uncoloured reflexion films for beam-splitting, coloured reflexion and transmission films for coloured filtering, and strongly selective transmission filters for narrow-wave-band filters (see *Nature*, **158**, 422; 1946). The second laboratory is being equipped as a General Physics Laboratory, where problems of instrument design and manufacture, such as the measurement and control of humidity, high-temperature thermocouple measurements, and the measurement of high resistance, are to be studied.

Benjamin Franklin House

ON June 27, Mrs. Lewis Douglas, wife of the American Ambassador in London, unveiled a commemorative tablet in Benjamin Franklin House, 36 Craven Street, London, W.C.2. This is the headquarters of the British Society for International Understanding, an educational organisation which was formed early in 1939 to promote among the British people a genuine understanding about other nations. It was in this house that Benjamin Franklin, one of the founders of the American Constitution, lived between 1757 and 1775 as agent for Pennsylvania, and carried out his electrical experiments, notably on the lightning conductor, and wrote much of his work. During the Second World War, the house was severely damaged by incendiary and explosive bombs. It has, however, been restored so far as possible to its original condition, with the aid of the American Philosophical Society, the Historical Society of Pennsylvania, the Franklin Institute of Philadelphia and Miss Caroline Bache, a great-great-great-granddaughter of Benjamin Franklin.

The British Society for International Understanding, as an independent, non-party organisation, relies entirely on subscriptions, donations, the sale of literature and payment for its services, the principal of which are the publications called "British Surveys". There are two types of "British Surveys". One is the main edition, intended for adult reading, and the other the popular series which are especially written for use in schools. Each survey gives accurate, unbiased background information on a particular country or an international topic. The main edition is published fortnightly and the popular series monthly. The Society also recommends lecturers and answers inquiries about foreign affairs and the British Empire. Mrs. Douglas said at the formal opening of Benjamin Franklin House that it was appropriate that his one-time home should be dedicated as the headquarters of a Society for International Understanding, for it would be hard to point to a more international figure than Benjamin Franklin. "It is Benjamin Franklin the world citizen we salute to-day. He lived in a period of collision and war, but he always stood for union and harmony and he became one of the great representatives of international culture."

Geological Society of Turkey

THE Geological Society of Turkey (Türkiye Geoloji Kuruma) was officially founded in June 1946 at Ankara. The headquarters are in the Institute of Mining Research, Ankara, and the officers are: *President*, Prof. H. N. Pamir; *Vice-President*, Dr. M. R. Egemen; *Secretary*, Dr. G. Otkun; *Treasurer*, M. Tasman. The objects of the Society are to promote geological research and encourage the study of geology, and to foster contact and collaboration between the various branches of applied geology. Its activities include conferences, lectures and discussions on geological topics; geological excursions both in Turkey and abroad; publication of a bulletin and memoirs of original research; establishment of a library; maintenance of close relations with similar bodies abroad and participation at international geological congresses. Much has already been done since the founding of the Society. Two conferences and an excursion have been held in Ankara, the first of which (February 24–28) comprised papers on local geology, including a comparison of Scotland and Turkey by Prof. W. J. McCallien, of the University of Ankara, and on petrology and geophysics, and a whole-day excursion to the Haymana region south of Ankara. Preparations are now being made for the publication of the first bulletin. The present membership is one hundred, and there are twelve foreign members and correspondents.

South-Eastern Union of Scientific Societies

THE fifty-first annual congress of the South-Eastern Union of Scientific Societies will be held at Brighton during July 14–19. The Corporation of Brighton has put the Royal Pavilion at the disposal of the Congress. The president-elect is Prof. W. A. F. Balfour-Browne, who will give an address on "The Possibilities of Natural History". The sectional presidents are E. J. Bedford (botany), A. H. Toms (geology), J. E. Ray (archæology), Prof. G. D. Hale Carpenter (zoology). A morning session will be devoted to a discussion on "The Place of Scientific Societies in the Promotion of Science", based on a circular letter received from the British Association. There will be an evening public lecture and film, "The Beginning of History", dealing with British prehistory, the introductory lecture being given by E. Cecil Curwen, and a film programme for schools designed to promote interest in local natural history and archæology. The honorary general secretary of the Union is H. M. Montford, 23 Mountside, Guildford, Surrey, from whom particulars of the Congress can be obtained.

University of London

THE following appointments have been announced: Dr. K. J. Franklin, acting director of the Nuffield Institute for Medical Research, Oxford, to the University chair of physiology tenable at St. Bartholomew's Hospital Medical College, as from October 1; Dr. Margaret M. A. Murray, since 1925 lecturer in physiology at Bedford College, to the University chair of physiology tenable at the College, as from October 1; Dr. Margaret Fishenden, during 1932–45 honorary lecturer in the Mechanical Engineering Department at the Imperial College of Science and Technology and since 1945 senior lecturer in heat transmission, to the University readership in applied heat tenable at the College, as from October 1; Mr. H. E. O. James, since 1926 lecturer in psychology at the University of Manchester, to the University readership in psychology tenable at the Institute of Education, as from October 1.

The title of reader in commerce in the University has been conferred on Mr. Frederick Brown, in respect of the post held by him at the London School of Economics; the title of reader in electrical engineering in the University has been conferred on Mr. C. R. Stoner, in respect of the post held by him at Queen Mary College.

The degree of doctor of science has been conferred on W. J. Martin (Birkbeck College and the London School of Hygiene and Tropical Medicine) and on K. R. S. Morris (external student).

"The Corpus Allatum and the Control of Metamorphosis in Insects"

DR. V. B. WIGGLESWORTH writes: "In my letter in *Nature* of June 28, p. 872, I omitted, by an oversight, any reference to the important observation by Vogt that the corpus allatum of the first-stage larva of *Drosophila hydei* will induce egg production when implanted into the allatectomized adult female (*Biol. Zbl.*, **63**, 467; 1943). This provides further evidence for the identity of the juvenile and yolk-forming hormones."

Announcements

PROF. LINUS PAULING, professor of chemistry in the California Institute of Technology, has been appointed George Eastman visiting professor in the University of Oxford for the Hilary and Trinity terms, 1948.

MR. J. L. ADAM, chief surveyor to the British Corporation of Shipping and Aircraft, has been elected president, and Dr. J. H. Paterson vice-president, of the Institute of Welding.

DR. H. L. JENSEN, Macleay bacteriologist of the Linnean Society of New South Wales, Sydney, has been appointed chief of the Division of Bacteriology of the State Laboratory of Plant Culture, Danish Ministry of Agriculture.

AT the annual general meeting of the British Standards Institution, held on June 27, Lord McGowan, of Imperial Chemical Industries, Ltd., was elected president in succession to Lord Woolton; and Sir Clifford Paterson, director of the Research Laboratories of the General Electric Co., Ltd., chairman of the General Council in succession to Sir William Larke.

THE Society of Dyers and Colourists is organising a symposium on "Recent Advances in the Theory and Practice of Dyeing" to be held at Blackpool during September 25–27. Those likely to attend are asked to communicate with the General Secretary, The Society of Dyers and Colourists, 32–34 Piccadilly, Bradford.

A CONFERENCE on "Emission Spectra of the Night Sky and Auroras" is to be held in the rooms of the Royal Society during July 7–10. Among the speakers from outside Britain will be G. Dejardin, J. Dufay and R. Bernard (Lyons), D. Barbier, J. Cabannes, A. and E. Vassy, J. Bricard and A. Kastner (Paris), C. T. Elvey (Inyokern, California), J. Kaplan (Los Angeles), M. Nicolet (Brussels), E. O. Hulbert (Washington), R. Grandmontagne (Villeurbanne, Rhone), L. Harang (Tromsö), L. Vegard and C. Størmer (Oslo) and H. Alfvén (Stockholm).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption Spectra with Polarized Infra-Red Radiation

Elliott and Ambrose[1] have described measurements with polarized infra-red radiation. In a previous paper[2], we have explored the use of polarized radiation in studying the absorption spectra of oriented polymers. We have now extended this work by a much-improved technique, using large selenium mirrors to obtain the polarization, and have measured the spectra of many substances between 2 and 15 μ. Particularly interesting results have been found with crystalline solids such as simpler amides, dibenzyl, benzyl and diphenyl acetylene. A small amount of the solid is melted between a pair of rock-salt plates and allowed to crystallize so as to obtain so far as possible a linear orientation of the crystal growth.

When examined in polarized radiation with the direction of crystal growth successively parallel and perpendicular to the plane of polarization, marked spectral changes were found. Bands which are weak in one case are strong in the other; it is probable that the differences would be even more marked and informative if the crystalline orientation could be made more complete. The reality of the effects is proved by replacement of the selenium polarizing mirror by a plane aluminium mirror, when all the bands appearing in either of the other two cases appear together.

A very interesting feature is noticed with some of the amides, where the stretching vibration bands of the C=O and N—H bonds at 1655 cm.$^{-1}$ and 3250 cm.$^{-1}$ appear strong when that of the N—H deformation at 1545 cm.$^{-1}$ is weak, and *vice versa*. This could at once be explained if the amides are associated through hydrogen bridges of the type usually accepted and confirmed spectroscopically[3], namely, involving the link —C=O···H—N—. In different amides, which may differ in their internal crystal structure and hence in the arrangement of the bridges, the effect observed varies in degree. The results therefore confirm this type of association, and also provide a new reason for attributing the band at 1545 cm.$^{-1}$ to the deformation of the N—H bond, about which there has recently been some doubt. Moreover, they suggest that it may be possible to use this method in studying the structure of polyamides.

We are extending this work to unstretched and stretched rubbers, derivatives of cellulose, and nylons, with which similar changes have been found, and we are also applying it to peptides and proteins such as myosin. A detailed account will be published later elsewhere.

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[1] *Nature*, **159**, 641 (1947).
[2] Thompson and Torkington, *Proc. Roy. Soc.*, A, **184**, 3 (1945); *Trans. Farad. Soc.*, **41**, 260 (1945).
[3] Richards and Thompson, *J. Chem. Soc.*, in the press.

Polarized Infra-Red Radiation as an Aid to Crystal Analysis

The optical properties of crystals have been widely used as subsidiary data in X-ray structure analysis. Recent advances in infra-red spectroscopy now make it possible to extend the optical measurements into the region of molecular vibrational frequencies. Since certain infra-red absorption bands of organic molecules can be assigned to vibrations largely localized in certain substituent groups, or to vibrations of the molecule as a whole, a study of infra-red dichroism gives information about the orientation of the groups or molecules in the crystal. For example, if all the molecules in a crystal are equally oriented with respect to the crystal axes, then the minimum absorption of polarized infra-red radiation will be observed when the plane of polarization contains the direction of the change of electric moment produced by the molecular vibration responsible for the absorption. If the crystal contains two sets of mutually inclined molecules, the maximum absorption occurs when the plane of polarization bisects the obtuse angle between the two planes containing the directions of the electric moments and the incident beam. From the ratio of the maximum to minimum optical densities, the angle between the planes can be calculated. Information of this sort can be obtained with the aid of an extremely simple polarizing attachment to a standard infra-red spectrophotometer.

A polarizer was constructed from two surface-aluminized concave mirrors and a plane selenium mirror. The latter was made by melting selenium between a metal plate and a plane glass plate; on cooling, the glass plate was removed, leaving a highly reflecting selenium surface. The first concave mirror was arranged to throw a parallel beam of light from a Nernst filament on to the selenium mirror at the polarizing angle, and the second mirror to condense it on to the crystal sample placed in the usual position relative to the spectrophotometer. The electric vector in the polarized beam was parallel to the length of the slit, and the sample could be rotated about the axis of the beam. The samples were prepared as thin sheets between rock-salt plates by crystallizing from the melt until a parallel growth of crystals was obtained.

The efficiency of the polarizer may be judged from the fact that the transmission of a sample of succinic acid at 2,900 cm.$^{-1}$ decreased from 75 to 1·5 per cent as the plane of polarization was rotated from the [*c*] axis to a perpendicular direction. The [*c*] axes of the acicular crystals in this sample, which was a high-temperature form of unknown crystal structure, were parallel to one another, but the crystals assumed two different orientations about this axis. The great change in absorption of the broad band extending from 3,250 cm.$^{-1}$ to 2,300 cm.$^{-1}$, due to hydrogen-bonded hydroxyl groups, indicates that the O—H bonds must all be nearly parallel to one another and to the [*c*] axis. This is known to be the case in the form stable at room temperature[1].

In the case of a sample of *p*-benzoquinone, tabular on the (100) face, none of the bands showed very intense dichroism. In the crystal structure of benzoquinone determined by X-ray methods[2], the angle between the [*b*] axis and the projection of the C=O bonds on the (100) plane is approximately 33°. Several of the absorption bands, including those associated with the C=O and C—H fundamental

frequencies, exhibited dichroism corresponding to angles between 32° and 40°.

As a further test of the method, acetanilide was examined by polarized infra-red radiation, and the conclusions reached were checked by an independent X-ray examination kindly made by Mr. D. E. C. Corbridge, of these Laboratories.

In the sample examined, the crystals (space group P_{bcn}) formed as needles elongated along the [*b*] axis and tabular on (100). Most of the bands exhibited a maximum absorption parallel to the [*b*] axis, but a few, including that at 759 cm.$^{-1}$ attributed to the flapping motion of the benzene ring, exhibited a maximum absorption parallel to the [*c*] axis. From the ratio of maximum to minimum optical densities of the various bands, it was calculated that the benzene rings were inclined at about 20° to the (001) plane, and the projections on (100) of the hydrogen-bonded N—H and C=O bonds were each inclined at about 30° to the [*b*] axis. From the observed optical densities, it was estimated that the C_6H_5—N bonds must lie at a fairly small angle to the [*a*] axis. These conclusions are in agreement with the general arrangement of the molecules as deduced from the preliminary X-ray study.

A further possibility, which has not yet been examined, is to reverse the process and use the infra-red dichroism of crystals of known structure to analyse the infra-red spectra or to check proposed assignments of fundamental frequencies.

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[1] Verweel, H. J., and MacGillavry, C. H., *Z. Kristall.*, A, **102**, 60 (1939).
[2] Robertson, J. M., *Proc. Roy. Soc.*, A, **150**, 106 (1935).

Oxidation of Neostrychnine

The action of bromine on neostrychnine, $C_{21}H_{22}O_2N_2$, in cold acid solution affords a bromohydrobromide transformed by hot water into the hydrobromide of oxodihydroallostrychnine (formerly called oxodihydroneostrychnine), $C_{21}H_{22}O_2N_2$, in nearly theoretical yield. This substance has now been recognized as an aldehyde, and its formation involves a molecular rearrangement, $:N.CH=C: \rightarrow :N—C(CHO):$. It is noteworthy that the reverse transformation can be realized. Catalytic reduction of the aldehyde in alcoholic solution gives a dihydro-derivative, probably the related primary alcohol; in acetic acid solution an isomeride is produced in addition, and this is converted with great ease by dilute mineral acids into neostrychnine. Nitrous acid transforms neostrychnine into a ketoxime-formamide, $:N.CH:C: \rightarrow :N.CHO\ HON:C:$, which is hydrolysed by dilute hydrochloric acid to hydroxylamine, formic acid and a hydrochloride, $C_{20}H_{23}O_3N_2Cl$. This is a salt of a *sec*-basic ketone.

Taking into consideration what is already known in regard to the environment of the basic nitrogen of strychnine, these observations establish the relation of neostrychnine to strychnine. Under the influence of Raney nickel (and in other ways in certain derivatives), the double bond moves just one step in the direction of the basic nitrogen atom. This implies a new view of the methoxylating fission of the metho-salts of the alkaloids.

The direct explanation of the formation of oxodihydroneostrychnine (now termed oxodihydroallostrychnine) and its reconversion to neostrychnine was

$$—CH:C(N:). \rightarrow —CO.CH(N:). \rightarrow —CH(OH).CH(N:). \rightarrow —CH:C(N:),$$

and on this basis the older type of formula for strychnine was untenable. The discovery of unexpected and somewhat remarkable molecular rearrangements disposes of this natural explanation. It does not disprove the quinuclidine formula recently proposed[1]; but it removes the necessity for its postulation and, in these circumstances, we revert, as the best hypothesis to guide future work, to an earlier suggestion[2]. The relation of this structure to that of cinchonine has already been indicated[3]. Several slight modifications of this expression are feasible, and these have special advantages and disadvantages which must be discussed at a later date, especially since it is probable that crucial experimental tests can be devised.

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[1] Robinson, R., *Nature*, **159**, 263 (1947).
[2] Robinson, R., *Experientia*, **II**, 1, 28 (1946). Briggs, L. H., Openshaw, H. T., and Robinson, R., *J. Chem. Soc.*, 903 (1946).
[3] Openshaw, H. T., and Robinson, R., *Nature*, **157**, 438 (1946).

Fluorescence of Cancerous and Non-Cancerous Lipoids

In a previous communication, evidence was given[1] indicating the presence in human cancer tissue of a fraction, or fractions, the fluorescent spectra of which were similar to, if not identical with, those produced by methylcholanthrene. The fluorescence produced in a similarly treated lipoid fraction obtained from non-cancerous livers was considerably weaker, and appeared in a different region of the spectrum.

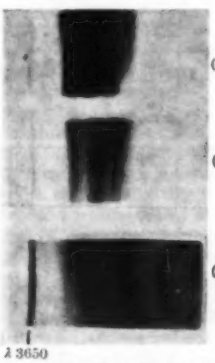
These findings were disputed by Hieger[2], and, in an exhaustive study of lipoids obtained from human cancerous and non-cancerous livers, Jones and May[3] failed to identify any methylcholanthrene-like compounds in human cancer tissue.

It should be emphasized at the outset that the expression 'methylcholanthrene-like' referred specifically to the similarity of the bands produced by the two substances. However, since even the existence of such bands in cancerous liver lipoids was questioned, the present work was undertaken to check the original contention, and to secure a more satisfactory procedure for the isolation and concentration of the material giving the banded fluorescent spectrum. A method was finally developed which has given fairly consistent results. Briefly stated, the procedure is as follows.

The acetone-soluble fraction is obtained as already described[4]. This lipoid is then saponified with 10 per cent potassium hydroxide in 70 per cent ethanol in a ratio of 1 : 10 for 24 hours. The ethanol is removed, the residue taken up in ethyl ether, and washed with distilled water until neutral to litmus. The solvent is then removed and the residue resaponified for four hours. The final residue is taken up in acetone and a

part of the free cholesterol removed by refrigeration and filtration. After the removal of the acetone, the residue is taken up in hexane, passed through a column of activated alumina, and developed with hexane. This resolves the lipoid into three main fractions: (1) the upper third of the column is occupied by a light brown to yellow zone; (2) a light-bluish fluorescent zone comprising the rest of the column; (3) a filtrate. The column is then partly dried by air, the two fractions separated, extracted repeatedly with methanol, and filtered. The methanol is removed under reduced pressure and the residue taken up in hexane. The yellow material (top zone) is then passed through a column of silicic acid. This resolves the lipoid into four to six bands of various gradation of brown (from dark to light), a pink and red band, and on repeated washing, a zone of blue fluorescence at the bottom of the column. The lower fraction is separated, extracted with methanol, which is later removed at reduced pressure, the residue is taken up in hexane, and photographed as previously described[1]. An alternate procedure is to treat this fraction by repeated washings with hexane, and recover it from the filtrate.

As to the other fractions appearing in the column, they give either a continuous spectrum or are non-fluorescent. Quantitatively, the recovery of this material varies. In a typical instance, about 2,400 gm. of tissue will yield 56 gm. of total lipoid. Upon saponification the latter will give 1·5 gm. of unsaponifiable material. After passing it through a column of activated alumina, and then through a column of silicic acid, the material will give 15 mgm. of bluish fluorescent material, producing the characteristic spectroscopic banded structure.



(*a*) FLUORESCENCE OF FRACTION FROM CANCEROUS TISSUE; (*b*) FLUORESCENCE OF METHYLCHOLANTHRENE; (*c*) FLUORESCENCE OF FRACTION FROM NORMAL TISSUE

The results illustrated by the figures are self-explanatory. The bands obtained from the cancerous unsaponifiable fraction show a slight shift toward the 3650 mercury line, and do not agree exactly with the bands produced by methylcholanthrene. On all three spectrograms the long wave-length is to the right of the 3650 line of mercury. The 'bands' in (*a*) are shifted slightly to the violet relative to those in (*b*). When the originals of (*a*) and (*c*) are compared it looks as if the same bands occur on the two plates. The intensity of the fluorescence in the normal is too low to prevent the mercury lines 4047, 4074 and 4358 from coming through. That, and a shift of intensity toward the red, gives us the difference in the two plates. It seems reasonable to conclude that the fluorescences in (*a*) and in (*c*) arise from the same substance. The substance is present in greater amounts in cancerous than in non-cancerous material.

The comparison with methylcholanthrene does not imply the presence in the cancerous lipoid of a fraction identical with the known carcinogens. It indicates: (1) the presence of substances giving banded structures in the unsaponifiable fraction obtained from cancerous livers, and, to a certain extent, in non-cancerous livers; and (2) the close similarity between the bands obtained from a fraction endogenous in character, and a synthetically prepared exogenous compound.

This material was found on analysis to consist largely of a saturated hydrocarbon which on catalytic micro-hydrogenation failed to take up hydrogen. Since the saturated hydrocarbon could not be responsible for the fluorescence, it is evident that the latter is due to a component or 'admixture', and present in a relatively very small amount. Investigation of this fraction is now in progress.

This work was repeated and confirmed by Dr. B. Krichesky, associate professor of zoology, at the University of California, at Los Angeles. A detailed report of the method employed will be published elsewhere.

These investigations were supported by a grant from the Jewish Fund for Medical Research to the University of California and carried out under the supervision of the Committee on Cancer Research.

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[1] Penn, H. S., *Nature*, **149**, 193 (1942).
[2] Hieger, I., *Nature*, **149**, 300 (1942).
[3] Jones, R. Norman, and May, C. D., *Cancer Res.*, **4**, 304 (1944).
[4] Penn, H. S., and Jacobsen, Elly N., *J. Immun.*, **54** (Sept. 1946).

Molecular Compounds Involving Copper Diphenylacetate

THE copper salts of many organic carboxylic acids are soluble in alcohol (see Beilstein). It has now been found that although a few are soluble in benzene, for example, copper hydrocinnamate, many which are insoluble in benzene will dissolve readily on addition of a few drops of alcohol; for example, copper phenylacetate, diphenylacetate, *o*-toluate.

Copper diphenylacetate has been studied in more detail. This compound crystallizes from hot absolute alcohol in large light-green octahedral crystals containing two molecules of alcohol. The combined alcohol is lost on standing in the open, and the crystals become darker in colour without apparent change in form. The light-green material containing alcohol is readily soluble in benzene, whereas the darker green compound is not. If copper diphenylacetate is crystallized from aqueous alcohol, needle crystals are obtained without alcohol, and these are insoluble in benzene.

It would seem from this that the substance possessing benzene solubility is $CuA_2.2EtOH$ (where A is the diphenylacetate radical). The molecular weight of this compound determined cryoscopically in benzene varied from 350 to 430 with the concentra-

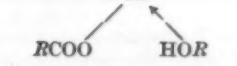
tion. This is lower than the calculated value of 578, but shows that there is only one atom of copper in the molecule.

Copper diphenylacetate combines with many other alcohols. The following have been investigated :

Alcohol	Crystalline form	Mols. alcohol : mols. CuA_2
PRIMARY		
Methyl	—	no compound isolated
Ethyl	octahedra	2 : 1
n-Propyl	octahedra	2 : 1
n-Butyl	octahedra	2 : 1
n-Amyl	octahedra	2 : 1
n-Octadecyl	—	no compound isolated
iso-Butyl	octahedra	2 : 1
Allyl	octahedra	2 : 1
Benzyl	needles	2 : 1
SECONDARY		
iso-Propyl	—	no compound isolated
sec-Butyl	prisms	indefinite
cyclo-Hexanol	needles	1 : 1
TERTIARY		
tert-Butyl	plates	2 : 1
Amylene hydrate	needles	1 : 1
Triphenylcarbinol	—	no compound isolated

The last two compounds with tertiary alcohols are remarkable in being quite stable in contact with the atmosphere.

In the 2 : 1 compounds, it is probable that the alcohol molecules are linked to the copper atom by donation of electrons from their oxygen atoms :



Cis and *trans* arrangements would be possible if the copper atom had the usual planar valency distribution. These have not so far been observed.

The combining powers of copper diphenylacetate are not restricted to alcohols. Acetone gives a 1 : 1 compound (plates), ethyl acetate a compound of indefinite composition (plates), aldehydes dissolve copper diphenylacetate very readily, and pyridine gives a 1 : 4 compound (azure hexagonal plates).

Publication in full will be made elsewhere. The comparative solubility of copper salts of organic acids is being investigated.

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Highly Active Triphenylethylene Derivatives

TRIPHENYLETHYLENE[1] and several active derivatives[2-4] have been shown to possess a prolonged œstrogenic activity provided that a dose well above the threshold is administered. Among these, αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene[4] has been especially noted for its considerable prolonged œstrogenic activity when administered orally. A considerable prolonged action has also been noted[3] when a dose well above the threshold of diethylstilbœstrol dimethyl ether is administered subcutaneously. Emmens[5] has attributed the prolonged action shown on injection of the higher doses of methyl ethers of diethylstilbœstrol and of œstrone to "the slowness with which the body effects hydrolysis of such ethers, without which they cannot be esterified and excreted".

αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene (m.p. 205–7°) has been found to possess, when administered by subcutaneous injection, a relatively high potency; but the duration time, like that of diethylstilbœstrol[5], is not appreciably increased with increased dosage. When administered by subcutaneous injection, its diacetate ester (m.p. 157–159°) has a more prolonged action, and its minimal effective dose is lower. In contrast to αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene, which is a pro-œstrogen[7], both αα-di-(*p*-hydroxyphenyl)-β-phenylbromoethylene and its diacetate ester have been found to be true œstrogens.

αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene is readily obtained from αα-di-(*p*-isopropoxyphenyl)-β-phenylbromoethylene (m.p. 116–118°). The latter is prepared by brominating αα-di-(*p*-isopropoxyphenyl)-β-phenylethylene (m.p. 83–84°). On heating αα-di-(*p*-isopropoxyphenyl)-β-phenylethylene in vacuum at 220–230° with a drop of 20 per cent sulphuric acid, αα-di-(*p*-hydroxyphenyl)-β-phenylethylene (m.p. 178°) is obtained in quantitative yield. αα-Di-(*p*-acetoxyphenyl)-β-phenylethylene (m.p. 84°) and αα-di-(*p*-propionoxyphenyl)-β-phenylethylene (sinters at 62° and melts at 65–66°) are obtained by heating αα-di-(*p*-hydroxyphenyl)-β-phenylethylene with acetic anhydride and propionic anhydride respectively. αα-Di-(*p*-acetoxyphenyl)-β-phenylbromoethylene has been prepared by brominating αα-di-(*p*-acetoxyphenyl)-β-phenylethylene.

The œstrogenic activity of some triphenylethylene derivatives is shown in the accompanying table. The substances were dissolved in oily solution.

Substance	Subcutaneous injection		Oral administration (stomach tube)	
	Dose (μgm.)	Duration until action halved (days)	Dose (μgm.)	Duration until action halved (days)
αα-Di-(*p*-hydroxyphenyl)-β-phenylethylene	50 75 100 200 375 750	Slight effect 2 2 3 3 4	1000	Nil
αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene	1 2 10 15 100	Nil Slight effect 4 5 8	10 20 25 50 100	Slight effect 3 3 3 3
αα-Di-(*p*-acetoxyphenyl)-β-phenylethylene	1000	9		
αα-Di-(*p*-acetoxyphenyl)-β-phenylbromoethylene	0·2 0·5 1 2 10 1000	Slight effect 5 5 5 9 24	10 50	3 6
αα-Di-(*p*-ethoxyphenyl)-β-phenylbromoethylene			10 50 500	7 21 38
αα-Di-(*p*-propionoxyphenyl)-β-phenylethylene	100	6		
αα-Di-(*p*-isopropoxyphenyl)-β-phenylbromoethylene	100 1000	6 128		

One of us (W. T.) would like to express his gratitude to Prof. E. E. Turner for offering facilities to carry out chemical work in the Chemistry Department, Bedford College, University of London, during his stay in England. He would like also to thank Prof. A. Schönberg, Chemistry Department, Faculty of

Science, Fouad I University, Cairo, for his interest in the progress of the work. The expenses of this investigation have, in part, been defrayed by a grant from the Medical Research Council (to J. M. R.).

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[1] Robson, J. M., and Schönberg, A., *Nature*, **140**, 196 (1937).
[2] Robson, J. M., Schönberg, A., and Fahim, H. A., *Nature*, **142**, 292 (1938).
[3] Robson, J. M., Schönberg, A., Tadros, Wadie, and Fahim, H. A., *J. Chem. Soc.*, 1327 (1940).
[4] Schönberg, A., Robson, J. M., and Tadros, Wadie, *Nature*, **150**, 22 (1942); the name of the third author was inadvertently omitted in this publication.
[5] Dodds, E. C., Golberg, L., Lawson, W., and Robinson, R., *Proc. Roy. Soc.*, B, **127**, 140 (1939).
[6] Emmens, C. W., *J. Endocrin.*, **1**, 142 (1939).
[7] Robson, J. M., and Ansari, M. Y., *J. Pharm. Exp. Ther.*, **79**, 340 (1943).

A Volatile Compound of Copper

IN search of the cause of a copper deposit formed in some incandescent lamps with copper electrodes, we examined the thermal decomposition of some organic copper salts. Cuprioxalate yields copper oxides, and cuprimesoxalate a mixture of copper oxides with elementary carbon. Cupriformate, however, decomposes at about 200° C., evolving partially a volatile compound of copper which immediately decomposes, forming a red smoke of elementary copper, and coating the near hot glass surface with a brilliant mirror of metallic copper. Where this mirror was thin, it resembled in every way the red deposit found in incandescent lamps.

Cupriformate may be decomposed in a horizontal glass tube in a stream of non-oxidizing gas, and its volatile product of decomposition is thus carried quickly out of the hot zone and saved from decomposition. It may be transported by the gas through a dense filter of cotton wool several centimetres long in a glass tube over a distance of more than 40 cm., and if the gas is ignited there, the new compound makes the flame an intense green. If, however, a remote part of the tube through which the compound is swept by the gas is heated externally, a beautiful copper mirror is formed. The unheated part of the tube between the cupriformate and the heated section remains absolutely clear. In a preliminary experiment, more than 1 per cent of the copper present in the decomposed cupriformate was recovered in the remote mirror. This reaction is useful in the quantitative study of the behaviour of the new compound, the isolation of which has not yet been accomplished. It is readily adsorbed on glass wool and to some extent on cotton. It condenses together with droplets of water—resulting from the formate—on the glass tube, and may be driven thence by gentle heating. The diluted gas stream is uncoloured; but around the decomposing cupriformate the gas phase is sometimes olive-green.

Formates of nickel, iron, cobalt, zinc and cadmium decompose without mirror formation. The extremely labile silver formate, however, yields a mirror on thermal decomposition, and silver oxide does the same when heated in a stream of reducing gas containing formic acid vapour. It is interesting that this reaction of the formates is not observed with the carbonyl-forming metals but occurs with two metals of the first sub-group of the periodic system. Experiments with gold are in progress. *Feb.* 21.

The existence of a copper carbonyl has been already postulated[1-4] but was seemingly disproved by Mond and Heberlein[5], who found no copper mirror in a glass tube after passing a mixture of carbon dioxide and monoxide over cupric oxide. In a recent communication in *Nature*, H. Bloom[6] reports having confirmed Bertrand's[2] original claim. His experiments are convincing in respect to the formation of a volatile copper compound, which is probably identical with the one formed from cupriformate. The term 'copper carbonyl', however, needs further examination. At the beginning we also thought that we were dealing with a carbonyl, but the facts that (1) the formates of the carbonyl-forming metals are inactive and (2) that of the three copper salts examined the two yielding carbon monoxide and dioxide were inactive, and only the formate, which contains hydrogen, was found active, made us hesitate. Experiments quite similar to those of Bloom showed mirror formation only if at least traces of organic compounds containing hydrogen were present in the gas. Metallic copper never reacted, only the oxide, and that only if a reducing gas was used. It would be very interesting to repeat Bloom's experiment with carbon monoxide carefully purified from all traces of hydrogen compounds. Convincing evidence will be available only after isolation and analysis of the new compound. Experiments to this end are in progress.

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[1] Zelinsky, N. D., *C.R. Acad. Sci. Paris*, **177**, 1041 (1923).
[2] Bertrand, G., *C.R. Acad. Sci. Paris*, **177**, 997 (1923).
[3] Boomer, E., Mooris, H. E., and Argue, G. H., *Nature*, **129**, 483 (1932).
[4] Crivelli, E., *Chim. Ind. Agric. Biol. Realizz. Corp.*, **17**, 185 (1941).
[5] Mond, E., and Heberlein, Chr., *J. Chem. Soc.*, **125**, 1222 (1924).
[6] Bloom, H., *Nature*, **159**, 539 (1947).

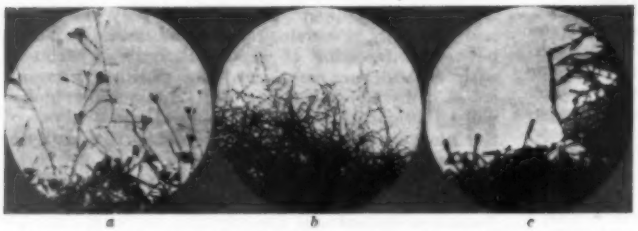
Action of 2-Aminofluorene on Moulds

Bielschowsky and Green[1] have noticed that 2-aminofluorene at a concentration of 1 : 10,000 is a growth inhibitor for *Staphylococcus aureus*. Such observations have been confirmed[2] and amplified by us. The influence exercised by this compound on two strains of *Penicillium* studied by us seems to us to be of particular interest.

Penicillium notatum Westling, strain 1219, is considerably hindered in its growth by saturating with 2-aminofluorene the Czapek–Turley medium, in which this substance dissolves only in traces. It is necessary first to sterilize the aminofluorene and then add it to the medium, otherwise the composition would be changed by heating. It seems that only sterile hyphæ are formed; there is no formation of characteristic conidiophore filaments. The hyphæ in coloured preparations appear to end with simple club-shaped swellings, or are reduced to fragments without causing the formation of conidia (see photographs); only very slowly does a sign appear of the formation of exospores.

At the second subculture, the growth on the surface is very seriously hindered, the mould developing mainly in the shape of isolated colonies at the bottom of the culture medium. At the same time, there are some modifications in the aspect of the culture, which shows a white colouring on the surface, without any sign of the characteristic blue-green colour on the surface of the crests of the folds as in the parent strain, while the mycelium on the reverse side takes a pink colour instead of golden yellow as in the original culture. The solution is much less intensely and much more slowly coloured, the production of penicillin being strongly hindered.

A somewhat different behaviour was shown by another variety of *Penicillium* isolated in this laboratory which secretes a bacteriostatic substance, active not only on Gram-positive organisms (staphylococci) but also on Gram-negative ones (typhus, cholera, etc.), that is, on micro-organisms against which the 2-aminofluorene has no bacteriostatic action. This mould, cultivated on mediums with 2-aminofluorene, also grows first without formation of conidia and looks like a white felt made of intertwined sterile hyphæ; but it accommodates itself more rapidly, and the conidiophore filaments with globular conidia of a characteristic dark green colour



a *b* *c*

Pen. notatum WESTLING. CULTURE 4 DAYS OLD. × 25. *a*, PARENT STRAIN ON TURLEY'S MEDIUM; *b* and *c*, GROWTH ON TURLEY'S MEDIUM WITH 2-AMINOFLUORENE

soon appear in isolated, later on confluent, zones. At the same time, and suddenly, the metabolism solution becomes a reddish-brown colour of a more intense hue, as compared with the control cultures cultivated on Turley medium of the same age. In successive transplantations the pigment appears more rapidly and is more intense, and the formation of the conidia seems to be less hindered, though the whole culture shows signs of suffering. A characteristic is the behaviour of the bacteriostatic action, which in the metabolic solutions of the moulds, cultivated on medium to which 2-aminofluorene has been added, appears after some delay, but reaches higher values and persists much longer, at least in the first transfers, both with Gram-positive and Gram-negative micro-organisms.

Besides the bacteriostatic action on the pyogenic staphylococcus observed by Bielschowsky, the 2-aminofluorene, therefore, interferes also with the metabolism of the moulds by hindering the formation of the exospores, modifying their mode of living, in some cases exciting and in others inhibiting the production of bacteriostatic substances.

ELISA MORELLI
GIACOMO MISLER

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[1] *Nature*, **149**, 526 (1942).
[2] *Farmaco*, in the press.

Pteroylglutamic Acid in Liver Extracts and Urine

IN order to undergo pupation and emergence, the larva of *Aedes ægypti* L. is dependent on the presence of 'folic acid' in the medium[1]. The use of water-extracted yeast residue makes it possible to replace the 'folic acid' of Williams by synthetic pteroylglutamic acid (*L. casei* liver factor) but not by thymine (in quantities up to 1 gm. per l. of medium) or by xanthopterin[1,2]. On the basis of these findings, we have used the metamorphosis of mosquito larvæ as a test for pteroylglutamic acid in liver extracts and urine.

Commercial liver extracts were tested at levels of 20 ml. ('crude' extracts) and 8 ml. ('refined' extracts) per l. of medium. Six liver preparations of established clinical potency were used, but only four were found capable of inducing pupation and emergence of the larvæ. The results for the three best 'refined' extracts were as follows:

Extract	Dry matter content	Larval response
A	170 mgm. per 1 ml.*	Strongly positive
B	140 mgm. per 2 ml.	Weakly positive
C	30–40 mgm. per 1 ml.	Negative

* The volumes quoted in each case represent 100 gm. fresh liver.

These observations may be accounted for on the basis of the different contents of pteroylglutamic acid, which do not appear to be related to the level of anti-pernicious anæmia factor present. Furthermore, the fact that a potent preparation such as *C* gives no larval response indicates that the anti-pernicious anæmia factor is incapable of bringing about pupation and emergence of mosquito larvæ.

Concentrates from 24-hour specimens of urine were prepared by a modification of the method of Wilkinson, Klein, Ashford, Jones, Mainwaring and Aylward[3]. In the urines of seven normal subjects, two of whom were tested twice, no pteroylglutamic acid could be detected. This result is in keeping with the observations of other workers[4–6], who found by microbiological assay that only a trace of 'folic acid' is excreted in human urine. In three of our normal subjects, assay by means of *S. lactis R* [7] showed the 24-hour urinary excretion of stimulating factor to be less than 0·6 μgm.

Four normal subjects were each given a course of liver injections intramuscularly, two receiving extract *A* and the others extract *C*. The total volumes administered in this way were 6 ml. and 8 ml. respectively. Twenty-four hour urine specimens were collected immediately following the termination of the liver treatment and again two weeks later. In all cases the larval response was negative, indicating that the excretion of pteroylglutamic acid had remained low. Over a long period it was found possible to carry out tests on similar lines on nine untreated patients with pernicious anæmia, each case being carefully investigated to establish the correctness of the diagnosis. The mosquito larva test was applied to the urine of these patients before and after liver therapy. The results are summarized below. As a negative control may be cited a case of myxœdema associated with macrocytic normochromic anæmia, which before and after thyroid and liver treatment showed little or no excretion of pteroylglutamic acid.

Although the number of cases investigated falls far short of what is desirable, there is a strong indication that clinical response to liver therapy is followed by greatly increased excretion of pteroylglutamic acid; that this increase bears no relation to any pteroylglutamic acid which may be present in the liver extract used; and that when liver is administered to normal or non-responsive subjects, pteroylglutamic acid excretion remains at a low level. The possibility of a dynamic relationship between pteroylglutamic acid and the anti-pernicious anæmia factor suggests itself.

Patient	M. larva test before treatment	Liver extract used*	Clinical response	M. larva test following treatment
1	−	*A*	+	+
2	−	*C*	+	+
3	±	*C*	+	+
4	−	*C*	+	+
5	±	*C*	+	+
6	−	*B*	+	−
7	−	*B*	−	−
		A	−	−
8 and 9	−	No further urine specimens secured.		

* The volumes of extract given were: *A* 3 ml., *B* and *C* 6–8 ml.

We should like to express our indebtedness to Prof. R. J. Williams for a specimen of 'folic acid' and to Dr. E. L. R. Stokstad for a supply of pteroylglutamic acid. Our thanks are also due to all those who co-operated in the collection of urine specimens, and to Miss M. Currie, Miss S. Sussman and Mr. J. M. Thorp for technical assistance.

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B. De Meillon
J. F. Murray
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April 13.

[1] Golberg, L., De Meillon, B., and Lavolpierre, M., *J. Exp. Biol.*, **21**, 90 (1945).
[2] Golberg, L., and De Meillon, B., *Nature*, in the press.
[3] Wilkinson, J. F., Klein, L., Ashford, C. A., Jones, T. S. G., Mainwaring, B. R. S., and Aylward, F. X., *Biochem. J.*, **34**, 698 (1940).
[4] Wright, L. D., and Welch, A. D., *Science*, **97**, 426 (1943).
[5] Mitchell, H. K., and Snell, E. E., *Univ. Texas Pub.*, No. 4137, 36 (1941).
[6] Johnson, B. C., Hamilton, T. S., and Mitchell, H. H., *J. Biol. Chem.*, **159**, 425 (1945).
[7] Teply, L. J., and Elvehjem, C. A., *J. Biol. Chem.*, **157**, 303 (1945).

Dependence of Anomaloscope Matching on Viewing Distance or Field Size

For the rapid detection of defective colour vision in personnel untrained in the use of optical instruments, an anomaloscope has been constructed in which a bipartite test field of 18 mm. diameter is viewed direct with both eyes. One half of the field is illuminated by light passing through a narrow-cut yellow filter (Ilford No. 812, maximum transmission at 580 mμ), and the other half by a variable mixture of the lights from a narrow-cut red filter (Ilford No. 608, transmitting above 640 mμ) and a narrow-cut green filter (Ilford No. 807, maximum transmission at 530 mμ). The instrument was designed so that the proportions of red and green light in the mixed half of the field could be obtained with fair accuracy from the reading of a single scale, and a control was provided for adjusting the brightness of the other half of the field. The brightness of the field was about 10 candles per sq. metre, permitting observations to be made in artificial light or dim daylight.

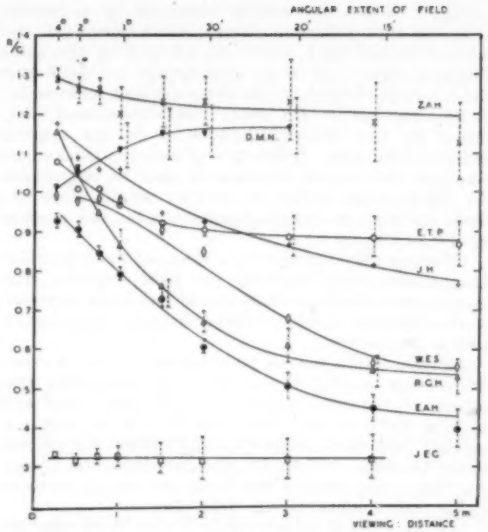

Fig. 1

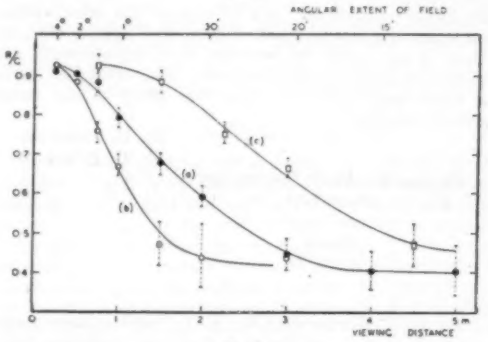

Fig. 2

It was found that the relative amount of red and green light (R/G) required to match the yellow was dependent on the viewing distance. The effect was so striking that most people, when shown their own 50-cm. match at a distance of 2 or 3 metres, at first believed the controls to have been altered.

Variation of the R/G ratio with viewing distance for a number of observers is shown in Fig. 1. In plotting these results, the average value of the ratio obtained by normal observers for a 2° field (that is, at 50 cm.) has been adjusted to equal unity. Where confusion would not thereby be introduced, dotted lines have been added to indicate the range outside which the observer definitely refused to accept any ratio as a match. It seems that individual observers show considerable differences in their types of behaviour, and that a group of observers who would be judged as normal at a short distance give widely different values of R/G at the longer distances even when allowance is made for the reduced precision. For most observers the amount of green required in the mixed field increases with the distance, and it will be noticed that the normal observer, E. A. H., requires almost as much green as the deuteranomalous observer, J. E. G., when the distance is increased beyond 3 metres.

Fig. 2 shows the results obtained by a reliable observer with a normal 18-mm. field, curve (*a*), and with a 6-mm. field, curve (*b*), plotted on the same distance scale. Curve (*c*) also applies to the 6-mm. field, but is plotted on the same angular scale as (*a*). It appears that the *R*/*G* ratio is not determined solely either by the viewing distance or by the angular extent of the field. Difficulties of accommodation and fixation, and visual aberrations, may be responsible for divergencies which, if absent, would allow the ratio to show a simple dependence on the angular extent of the field.

Whether this is true or not, it would seem desirable that investigators carrying out field inquiries with anomaloscopes of this class should pay some attention to the field-size and the viewing distance of the instruments they employ.

In view of the known peculiarities of colour vision within the central fovea, it is not surprising that effects of the type described should be found with angular fields of, say, less than 30′. It is more surprising that such effects should extend to angular fields between 1° and 3°, within which the colour-matching properties of the fovea are usually assumed to be independent of the field size.

We have asked many people if they have observed this effect before, but only Dr. J. H. Shaxby appears to have noticed it. He observed the effect when constructing his anomaloscopes, and agrees with us that it can only be because such instruments are generally fitted with eyepieces, and therefore have a fixed angle of view, that the effect is not more widely known.

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E. T. Purslow

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Brentwood,
Essex.
April 3.

Mr. R. G. Horner and Mr. E. T. Purslow have made a detailed study of the fact that the red-green ratio required to match a given yellow in the anomaloscope is dependent to a marked extent upon the distance of viewing (or the angular field). I observed this effect in my anomaloscope[1], and one of my students made a study of it. He is now unfortunately inaccessible, being in the Navy, and I am unable to quote his measurements; but his findings were approximately those given by Horner and Purslow, namely, a rapid change in the ratio at small distances, settling down to a constant value where the distance is large, that is, the angular field sufficiently small.

The peculiarities of central foveal vision alluded to by Horner and Purslow are presumably largely responsible for the change; though it must be noted that in my instrument the actual ratio of red to green light in the observed field must tend to vary with distance owing to the unequal scattering of green and red by the 'Diffusalyte' glass and the restriction of the light viewed to a smaller and more definite angle at greater distances.

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April 5.

[1] *J. Sci. Instr.* **22**, 15 (1945).

Shock Wave in Glass

During tests with an experimental high-speed camera developed at the National Research Laboratories[1], the photographs reproduced herewith (Fig. 1) were taken of a shock wave travelling through glass. The pictures indicate that the wave must travel through the glass at a speed of more than 18,500 ft. per sec.

The method of generating the shock wave is shown in Fig. 2. A 0·010-in. diameter copper wire was sealed through a 3/8-in. diameter × 10 in. long 'Pyrex' glass rod as shown. The copper wire was exploded electrically by discharging through it a 4 Mfd. condenser charged to 10,000 volts. An inch scale was marked on the illuminated background to facilitate measurement of velocity.

The high-speed photographs were taken in the order *A*-9, *A*-10, *B*-1, *B*-2, etc., with a time-interval between successive pictures of 15 micro-sec. A piece of black paper was placed in the lower right corner of the field to mask the flare from the exploding wire. This mask is seen in the photographs, obscuring the glass rod up to one inch above the wire.

The copper wire is seen to explode in picture *B*-3. In *B*-6, that is, 45 micro-sec. later, the upper end of the rod 10 in. away has been shattered. This implies that a shock wave travels along the glass with a speed of at least 18,500 ft. per sec. It is also apparent from the photographs that the glass does not shatter until some time after the shock wave

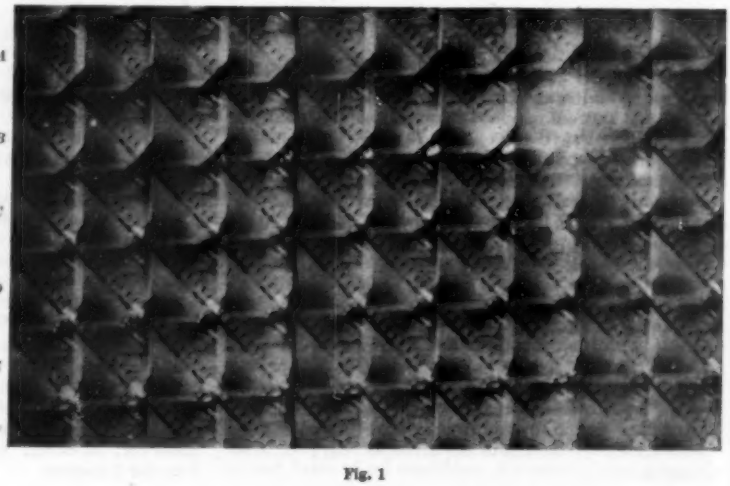

Fig. 1

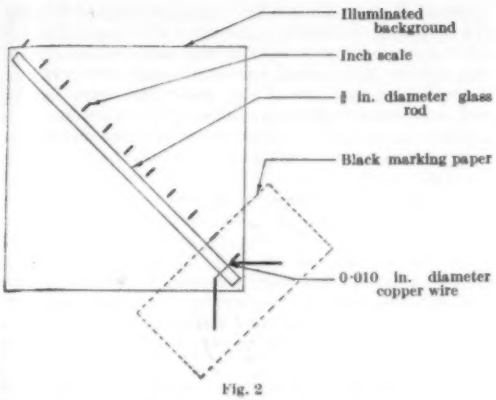

Fig. 2

has passed. It will be noted, for example, that the part of the rod three to four inches from the upper end has not broken until some time after the portions on either side of that region. Further, the time between the explosion and the shattering of the glass 3 in. from the lower end is considerably greater than the time between the shattering at the latter place and that at the upper end 7 in. farther along, that is, the shattering does not proceed along the rod with a definite velocity. It is inferred from this that after the shock wave has passed, the glass proceeds to shatter in the places where stresses are already concentrated, for example, at the end of the rod, or where annealing was poor. Thus the speed of the shock wave itself may be considerably greater than 18,500 ft. per sec. Indeed, the time between shattering at the 3-in. mark and the 10-in. mark is only 15 micro-sec., corresponding to a velocity of almost 39,000 ft. per sec.

Some portions of the rod as long as an inch were intact after the experiment, having apparently transmitted the very violent shock without fracturing. The portions that show opaque in the photographs were reduced to pieces the size of particles of sand.

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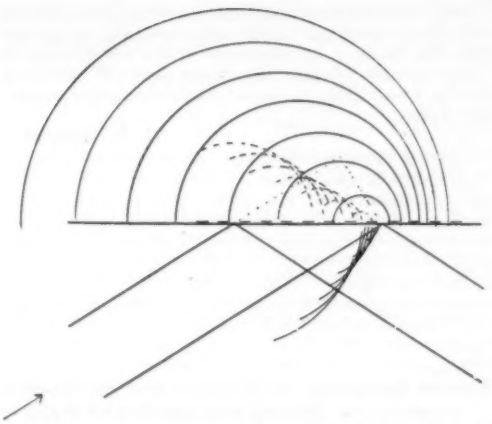
Dec. 19.

[1] Baird, K. M., *Canad. J. Res.*, A, **24**, 41 (1946).

Total Internal Reflexion and Huyghens' Construction: the Immersion Grating

It is not uncommonly supposed that if light falls on a dense-rare interface at more than the critical angle, no energy can penetrate into the rarer medium. Several workers[1] have shown that a certain amount of energy can penetrate a short distance, but that the disturbance is much attenuated and becomes negligible at a few wave-lengths distance from the interface. This is in accordance with Huyghens' construction[2] (see diagram, full circles), which gives in this case a series of secondary wavelets lying wholly within their neighbours, and hence not cutting and reinforcing at any considerable distance.

These secondary wavelets in the rarer medium can be made sensible and clearly visible by the use of a 90°, 45°, 45° prism (kindly prepared by the



Huyghens' construction for total internal reflexion
Full circles, conventional construction. Broken circles, showing wavelets emerging from a grating and reinforcing each other in the rarer medium

British Scientific Instrument Research Association), which has an array of opaque silver squares on its hypotenuse face, the intervening spaces being strips of clear glass-air interface. The silver suppresses some of the secondary wavelets, allowing the others to reinforce each other, in a number of directions, given by the generalized equation for an interfacial grating:

$$\frac{n\lambda}{d} = \mu_1 \sin\theta_1 + \mu_2 \sin\theta_2, \qquad (1)$$

where d is the grating space, λ the wave-length, n an integer, θ_1 and θ_2 the angles between the incident and emergent light and the normal in media of refractive index μ_1 and μ_2. θ_1 and θ_2 have the same sign if they are on the same side of the normal. The process is shown by the dotted circles in the diagram, which have been drawn an integral number of wave-lengths inside the corresponding and concentric full circles, with centres at the clear points of the interfacial grating.

If the treated prism is placed on the table of the spectrometer with the light incident at slightly less than the critical angle, the ordinary refracted beam (= zero order spectrum) emerges in the usual way and is clearly recognized by its intensity. If the prism be now turned slowly on the table to increase the angle of incidence, the refracted beam being followed in the telescope, the refracted beam disappears as expected when the angle of incidence becomes critical, but the higher order of spectra remain. In this way spectra have been observed emerging when the angle of incidence exceeds the critical by 25′ of arc.

A study of equation (1) suggests several possibilities. First, the device can be used for suppressing the zero order of a set of spectra or any other Fraunhofer diffraction pattern. Secondly, by putting μ_1 and $\mu_2 \sim 1{\cdot}7$, and θ_1 and θ_2 both positive and 65–70°, we can push up the value of the right-hand side to ~ 3. Thus if a very fine grating ($d \sim \lambda/3$) could be ruled on a transparent base of high refractive index, and a sandwich made of it with two prisms and liquid films of suitable refractive index, one could calibrate it using an optical spectrum in the first order. For contrast, μ_1 and μ_2 should both be high but different. Such a grating could then be used in the ultra-violet and soft X-ray region with added confidence. It could be called an 'immersion grating'.

Since a dense-rare interface becomes permeable to undulatory energy if ruled with a grating, it is clear that the classical explanation[3] of the production of X-ray spectra by glancing 'total internal' reflexion from a ruled glass or metal surface requires reconsideration.

G. L. Rogers

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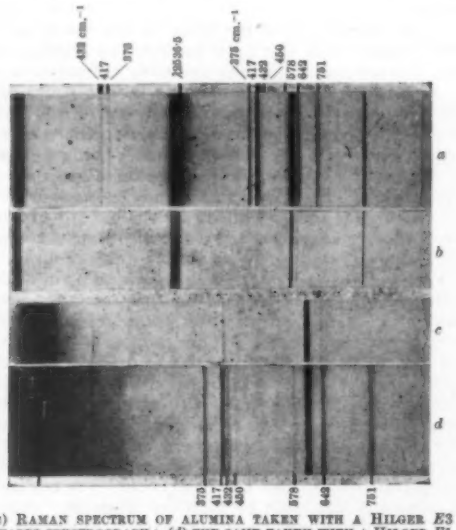
Dundee.
May 7.

[1] Wood, R. W., "Physical Optics" (Macmillan, 1934), chapter 12, p. 418 *et seq.*, gives a summary of this work.
[2] Airy, G. B. "Undulatory Theory of Light" (Macmillan, 1877), par. 35, p. 33, Fig. 10.
[3] Compton and Allison, "X-Rays in Theory and Experiment" (Macmillan, 1935), pp. 40 and 690.

Raman Spectrum of Alumina and the Luminescence and Absorption Spectra of Ruby

Studies of the Raman spectrum of crystalline alumina are rather scanty and incomplete, evidently because of its comparative feebleness and a continuous fluorescence accompanying it. Deutschbein[1], who was the first to investigate the case, recorded only a single frequency shift of 415 cm.$^{-1}$. Later, a second Raman line with a frequency shift of 376 cm.$^{-1}$ was noticed by Miss A. Mani[2]. A subsequent unpublished investigation by the latter[3] gave a hint of the existence of other faint lines besides the two already reported, among which two with frequency shifts 752 cm.$^{-1}$ and 633 cm.$^{-1}$ appeared most definite. It seemed likely that the use of the intense λ 2536·5 mercury resonance radiation as exciter would yield a much more satisfactory Raman spectrum for the substance. This hope has been realized in the present investigation. A large boule of synthetic alumina presented to Sir C. V. Raman by the Linde Air Products Co. of New York gave satisfactory results: unlike the majority of samples of synthetic alumina, this particular one did not become coloured under ultraviolet irradiation.



(*a*) Raman spectrum of alumina taken with a Hilger *E*3 quartz spectrograph; (*d*) the same taken with a Hilger *E*1 quartz spectrograph

(*b*) and (*c*) Comparison spectra of the mercury arc

Seven Raman lines with frequency shifts 375 (8), 417 (10), 432 (4), 450 (2), 578 (3), 642 (6) and 751 (7) cm.$^{-1}$ have been recorded in the alumina spectrum. The figures in brackets represent rough estimates of the relative intensities of the lines. Their positions as well as frequency shifts are marked in the accompanying spectrograms. A preliminary examination of the polarization characters indicated that the lines with frequency shifts 751 and 578 cm.$^{-1}$ should be assigned to the symmetric class and the rest to the degenerate class of vibrations. It is satisfactory to note that these results are in accord with the theoretical work of Bhagavantam and Venkatrayudu[4], who showed that the unit cell containing two Al_2O_3 groups has eighteen distinct frequencies of atomic vibration, of which two of the totally symmetric class and five of the doubly degenerate class should be active in the Raman effect.

The foregoing results are of interest in relation to the luminescence and absorption spectra of ruby which, as is well known, is crystalline alumina with chromic oxide impurity present as a colouring agent. The electronic transitions of the Cr^{+++} ion are responsible for the two intense lines at 6927 and 6942 A., as well as a few other fainter lines in the neighbourhood appearing at the same position in luminescence and absorption. Besides these, there is a host of bands appearing on both sides of the principal doublet which become sharper at low temperatures: they are then more intense on the longer wave-length side in luminescence and on the shorter wave-length side in absorption. The suggestion[1,2] that these may arise from the combination of the vibration frequencies of the alumina lattice with the electronic transitions of Cr^{+++} ions has been fully confirmed by the present investigation. In fact, nearly all the bands have been satisfactorily explained by taking account of the seven Raman frequencies as well as the lattice frequencies which are active in infra-red absorption and noticed by Coblentz[5], Strong[6] and Parodi[7]. The loading of the lattice by the chromium ions will give rise to a perturbation of the vibrational modes, and this would explain the fact that in fluorescence and absorption the lattice vibrations appear as diffuse bands and not as sharp lines.

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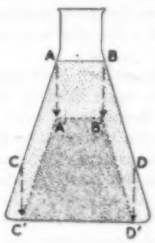
April 11.

Deutschbein, O., *Ann. d. Phys.*, **14**, 729 (1932).
[2] Mani, A., *Proc. Ind. Acad. Sci.*, A, **15**, 52 (1942).
[3] Mani, A., unpublished work.
[4] Bhagavantam, S., and Venkatrayudu, T., *Proc. Ind. Acad. Sci.*, A, **9**, 224 (1939).
[5] Coblentz, *Investigations of Infra-red Spectra*, **5**, 17, 34 (1908).
[6] Strong, J., *Phys. Rev.*, **38**, 1818 (1931).
[7] Parodi, M., *C.R. Acad. Sci. Paris*, **205**, 906 (1937).

A Sedimentation Phenomenon

One of us (F. S.) was required some time ago to consider a proposed sedimentation apparatus for particle-size analysis, in which, for reasons beyond the scope of this note, the sedimentation vessel was to be a conical flask. Assuming the motion of each particle to be one of vertical descent, it was shown that an unstable condition would ensue. Suppose time has elapsed for particles of a specified size to fall from AB to $A'B'$. At this moment, no particle greater

than the specified size will be above the surface $C'A'B'D'$, and the suspension within this region will have a higher specific gravity than the remainder. It was clear, therefore, that some flow of the suspension must occur and that the use of a conical flask would introduce an additional complication into the already difficult problem of particle size analysis.



Recently, one of us (R. J.) was shown a phenomenon which occurred after an aqueous suspension of potters' bone was shaken in a conical flask, and recognized it as connected with the above problem. When the flask was allowed to stand, normal settling commenced; but after a few moments, alternating layers of clear and cloudy liquid appeared to be moving up the sides of the flask. This upward movement is evidently one phase of the readjustment which theoretical consideration requires, but it occurs rhythmically and not as a steady flow.

A similar effect has been observed with straight-sided vessels slightly tilted, suggesting that, when using such vessels, care in the vertical setting of the apparatus is of importance.

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F. Smithson

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April 9.

Technique of the Analysis of Variance

The analysis of variance technique originally devised by Prof. R. A. Fisher for the interpretation of agricultural experiments concerned the case of equal frequencies in the sub-classes. Prof. Fisher himself extended his technique to the case of unequal frequencies[1], when only the effect of one single variable was under examination.

The more general case of unequal frequencies in the sub-classes and more than one variable was dealt with by Brandt[2] and Yates[3], the latter introducing constants fitted by the method of least squares. The analyses already mentioned are special cases of the results produced by this method.

The methods appropriate to the two simple cases can be developed by using orthogonal polynomials, but this is not possible in the general case. However, if the frequencies n_{ij}, say, are such that they can be separated into two factors $u_i v_j$, say, then orthogonal polynomials can again be constructed.

So far as I am aware, it has never been pointed out that this method is not equivalent to that of fitting constants, except in the two special cases mentioned earlier. For example, if two variables with two values each are considered, then the method of fitting constants leads to

$$(x_{11}+x_{12}-x_{21}-x_{22})^2/\left(\frac{1}{n_{11}}+\frac{1}{n_{12}}+\frac{1}{n_{21}}+\frac{1}{n_{22}}\right),$$

and that of proportionate frequencies to

$$\left(\frac{n_{11}x_{11}+n_{12}x_{12}}{n_{11}+n_{12}}-\frac{n_{21}x_{21}+n_{22}x_{23}}{n_{21}+n_{22}}\right)^2\Big/\left(\frac{1}{n_{11}+n_{12}}+\frac{1}{n_{21}+n_{22}}\right),$$

for the measure of the effect of the first variable.

It appears that different definitions of effects and interactions are implied by the two methods. This is logically unsatisfactory, since the definition of an effect or of an interaction should not depend on whether the frequencies are noticed to be such that a change in the definition leads to easier computations. The method of fitting constants should therefore always be accepted as the only legitimate one.

A detailed analysis, showing also that the case of proportionate frequencies is unique in making the introduction of orthogonal polynomials possible, will appear elsewhere.

S. Vajda

Statistical Branch,
Admiralty.

[1] Fisher, R. A., "Statistical Methods for Research Workers", 4th ed. § 44 (1932).
[2] Brandt, A. E., *J. Amer. Stat. Assoc.* (1934).
[3] Yates, F., *J. Amer. Stat. Assoc.* (1934).

Significance of Multiple Innervation of Cutaneous Pain 'Spots' in Relation to the Quality of Pain Sensibility

If a sphygmomanometer cuff is inflated at a pressure above systolic blood pressure on a human limb, a progressive loss of cutaneous sensibility occurs peripheral to the cuff. The work of Lewis, Pickering and Rothschild[1] in this connexion has been repeated and amplified. These authors describe a regularly ascending 'centripetal paralysis', and attribute this mode of spread to an increasing susceptibility of individual nerve fibres to the effects of pressure as they are traced proximally from the periphery. We have been unable to confirm any such regular centripetal spread of sensory loss. It has been found that, in the territory of any given nerve, loss of sensibility commences in different sites, not only in different subjects, but also in repeated experiments in the same subject, and spreads irregularly rather than centripetally. Indeed, in several instances an almost regular centrifugal spread has been observed.

If the hypothesis of Lewis *et al.* is correct, and individual nerve fibres do indeed become more susceptible to pressure the more proximally they are traced, then sensory paralysis should appear more quickly the more proximally the compressing cuff is situated on the limb. It is certainly the case that sensory loss occurs more quickly when the cuff is on the upper arm than when it is on the forearm. The evidence available, however, indicates that, owing to anatomical factors, pressure is transmitted more effectively to the underlying nerves when the cuff is in any position on the upper arm than when it encircles the forearm. Thus the observed difference between upper arm compressions and forearm compressions can be explained on purely mechanical grounds[2]. Direct evidence that there is no such sensitivity 'gradient', as suggested by Lewis *et al.*, may be obtained by altering the position of the compressing cuff on the *upper arm*. It is then found

that, whatever the position of the cuff, no difference can be observed in the time of onset of sensory paralysis.

Lewis *et al.* attribute the order of loss of the various sensory modalities in any skin area to a differing susceptibility of nerve fibres of large and small diameters. Our observations show that this hypothesis is inadequate to explain the results in detail. The manner in which any modality is lost appears to be fairly characteristic. Subjectively, there is first an alteration in the quality of the sensation, then prolongation of the response followed by delay in appreciation, and, finally, patchy loss of sensibility.

Our attention has been directed particularly to the alteration in the quality of pain sensibility which precedes the onset of analgesia. This altered quality appears to resemble very closely the unpleasant pain which can be elicited from certain cutaneous scars, and also from skin at the borders of areas which have either been recently denervated or are in the course of sensory recovery.

Sensory tests have been carried out in several such cases, and the areas of skin concerned have afterwards been examined histologically after vital staining with methylene blue. It was found that, in all cases where pain of an unpleasant quality could be aroused, the nerve nets and terminals subserving pain were invariably isolated from their neighbours, in contrast to the interweaving which normally obtains. In parenthesis, it may be remarked that such alterations in the peripheral pain network appear to be without effect on the threshold of pain sensibility, which was found to be correlated with abnormalities in the morphology of the endings. The lowest thresholds occurred when the subjacent pain fibres were surmounted by growth cones ending just beneath the basal layer of the epidermis.

Direct stimulation of pain fibres in a human digital nerve has shown conclusively that such fibres obey the 'all or none' law. It follows that no modification of the characteristics of the stimulus applied to a single pain fibre will give rise to any change in the quality of the sensation perceived. Taken in conjunction with the histological observations, this observation suggests that changes in quality are due to alteration of the number and peripheral pattern of the fibres involved in the conduction of impulses arising from a given stimulus. The alteration in quality of pain sensibility which occurs during compression of the arm is in strong support of the above hypothesis. The pain fibres do not all simultaneously cease to conduct, and there is, therefore, a period during which there is a progressive reduction in the number of active fibres proceeding from a given area, and also an alteration in the peripheral pattern of innervation. It is precisely during this period that alteration in the quality of pain sensibility occurs, and it is difficult to escape the conclusion that the subjective change is due to this process.

Further work along these lines is in progress, and it is hoped shortly to publish results in detail.

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[1] Lewis, T., Pickering, G. W., and Rothschild, P., *Heart*, **16**, 1 (1931).
[2] Weddell, G., and Sinclair, D. C., *J. Neurol., Neurosurg. and Psychiat.*, in the press.

British Folliculinidæ (Ciliata, Heterotricha)

Das[1] has recently reported the occurrence at Cullercoats of two species of Folliculinidæ hitherto unrecorded for Great Britain, namely, *Folliculinopsis producta* Wright and *Folliculina simplex* Dons. He stated that only three other species have been recorded from Great Britain: *F. ampulla* Müller (Plymouth and Port Erin), *F. elegans* Clap and Lach. (Port Erin), and *Parafolliculina hirundo* Kent (Channel Islands).

To this list can be added[2] *Folliculina viridis* Wright, which, three years ago, during an intensive study of a rock pool in Langland Bay, Swansea, I found attached in some numbers to the fronds of *Corallina officinalis*. *F. viridis* is easily confused with *F. elegans*; but the former can be distinguished[3] by its smaller size and yellow-green colour. The overall length of my specimens (fully extended) never exceeded 400 μ.

Last year, while examining the fauna associated with *Porcellana platycheles* in Langland Bay, Swansea, I found the upper surface of the carapace and legs liberally encrusted with the (mostly) empty tubes of *Folliculina*. 310 tubes were counted on one crab, 128 of these being on the carapace. The dimensions and shape of the tubes, and absence of green colour in the living organisms, accord with the description given by Faure-Fremiet[3] for *F. elegans*.

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April 21.

[1] Das, *Nature*, **159**, 502 (1947).
[2] Fowell, *Proc. Swansea Sci. and Field Nat. Soc.*, **2**, 192 (1944).
[3] Faure-Fremiet, *Biol. Bull.*, **70**, 353 (1936).

Erythrean Fishes on the Mediterranean Coast of Palestine

The presence of fishes of Erythrean origin in the Levant has been observed by several authors[1–6]. It has also been stated that these fishes must have traversed the Suez Canal and settled more or less finally in the Mediterranean. As this process of immigration of fishes into an entirely distinct region is going on continually, it may be of interest to list briefly those species which have been collected by workers of the Hebrew University and have so far been identified.

Atherina pinguis Lac.[1]	*Holocentrum rubrum* (Forsk.)
Hemiramphus far (Forsk.)[4]	*Mulloides auriflamma* (Forsk.)
Cyprinodon dispar (Rüpp.)[5]	*Teuthis sigana* Gthr.[2,3,4,6]
Therapon jarbua (Forsk.)	*Platycephalus* sp.
Apogon taniatus C.V.	*Monacanthus setifer* Benn.[3–4]

Four of the ten species listed here were mentioned by previous authors as captured in Palestinian or Syrian coastal waters. The remaining six have—so far as we are aware—not been recorded from Palestine or Syria as yet.

A discussion of the data published in this note will be given elsewhere.

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The Hebrew University,
Jerusalem. April 25.

[1] Norman, *Trans. Zool. Soc. London*, **22**, 3 (1927).
[2] Steinitz, W., *Pub. Staz. Zool. Napoli*, **8**, 3/4 (1927).
[3] Gruvel, "Les Etats de Syrie" (Paris, 1931).
[4] Hornell, Report on the Fisheries of Palestine (London, 1935).
[5] Mendelssohn, in the press.
[6] Kosswig, *C.R. Ann. Arch. Soc. Turque Sc. Phys. Nat.*, **10** (1942–43).

X-RAY CRYSTALLOGRAPHY

THE 1947 Conference of the X-ray Analysis Group of the Institute of Physics was held in the Royal Institution, London, on April 22 and 23. The first day was devoted to papers and discussion on the training of X-ray crystallographers for science and industry, and the second to descriptions of new techniques and results of X-ray analysis. The annual meeting of the Group was also held on the first day, and an evening lecture was given by Mr. H. P. Rooksby on "The Technique of X-ray Powder Photography" (see p. 7 of this issue).

It is impossible to give more in these notes than a very brief summary of the major contributions to the Conference. A fuller report will be published in the *Journal of Scientific Instruments*.

X-Ray Crystallographers in Industry

It became clear in the course of the two papers on this subject, and the discussion that followed, that there was general agreement on several interesting points. First, the demand for trained men still exceeds the supply, largely owing to a bottleneck in training; one way out of this difficulty, of which use has been made, is to send men already in industrial laboratories for short courses of training. This has the advantage that the workers are already acquainted with problems they will have to tackle, but the disadvantage that they cannot be spared for a length of time really adequate for training. Secondly, it was emphasized that a good X-ray analyst must have as broad a knowledge as possible of other sciences and techniques, in order to be able properly to assess the applications and limitations of his own technique.

Mr. D. A. Oliver suggested that a series of specialized monographs covering the whole theoretical and practical field would be useful to industrial X-ray crystallographers. He was of the opinion that, owing to general understaffing, industrial laboratories cannot usually offer much in the way of training apart from that in routine work, and that the present solution is that industry must assist in the training of research personnel by direct or indirect support of research in university departments.

Dr. L. Mullins gave details of a short course in X-ray crystallography given at Messrs. Kodak, Ltd., for industrial research personnel. Practical work includes the tackling of problems likely to arise in industry.

In the discussion, Sir Lawrence Bragg suggested that an appointments board in association with the X-ray Analysis Group might assist in the recruiting of X-ray crystallographers for industry. Mr. H. P. Rooksby was of the opinion that an industrial worker should be able to tackle fundamental problems, for which, however, a short course is not sufficient preparation. He also believed that those undergoing academic training would benefit by a period of apprenticeship in industry. Dr. W. A. Wooster agreed that work of a fundamental nature should be carried out in industry and suggested that research could usefully be divided into three types: (1) fundamental; (2) semi-fundamental; (3) technical. Dr. G. A. Jeffrey suggested that research organisations, when taking on university-trained men in order to start up an X-ray crystallography department, should take men from two or more university departments in order to ensure wide application of the technique.

Training of X-Ray Crystallographers in Polytechnics and Universities

The training of post-graduate chemistry students was discussed by Prof. E. G. Cox. This starts, in most universities, at a very elementary level, which is offset by a knowledge of the importance of the results of X-ray analysis to chemical problems. It is important to build on this by giving a man a research topic from the outset, which will encourage him both to acquire the necessary X-ray technique and also to widen his chemical horizons. Some formal instruction is considered necessary, covering crystal optics as well as X-ray analysis. Instruction in the latter is mainly concerned with structure analysis from single crystals, and here it is particularly important to find a suitable compromise between spending a great deal of time on learning to make and use equipment and do calculations, and becoming merely a machine-operator. To avoid the danger of becoming narrow-minded specialists, colloquia, visits to other workers, etc., are all important, but most important of all is the maintenance of the proper atmosphere in the laboratory.

The next speaker was Dr. H. M. Powell, who described the teaching in crystallography offered to students in chemistry at Oxford. It is realized that courses of two different types have to be provided: (*a*) for chemistry students generally, who need an outline knowledge of X-ray methods and their possibilities; and (*b*) for those intending to specialize in this work. Details of courses intended to meet this need were given, and stress was laid on the Oxford system of a graduate's fourth year of study, when a one-year research problem is tackled, sometimes leading on to further work.

Mr. F. Y. Poynton described how, in spite of all the difficulties of evening-class work, successful courses on the technical applications of X-ray diffraction had been run during the last few years, fitting into the general teaching of the Department of Applied Physics of the Northampton Polytechnic. The support of neighbouring industrial organisations had encouraged them to start recently a more detailed course for technicians beginning to use X-ray methods.

Dr. W. H. Taylor gave an account of the arrangements for teaching X-ray crystallography in Cambridge. He described the arrangements for Parts 1 and 2 of the Natural Sciences Tripos, and, leaving the Part 1 teaching to be described later by Dr. W. A. Wooster, went on to explain in detail the teaching for Part 2 students in chemistry, metallurgy and physics. Recognizing the two divisions of students mentioned by Dr. Powell, he showed how the content of each course is adapted to the needs and interests of each class of student and gave details of the practical work offered. He went on to describe the post-graduate work, explaining the advantages to the general outlook of students of the wide range of research, extra-mural, and administrative problems undertaken in the Cavendish Laboratory.

Dr. W. A. Wooster gave an account of the teaching of X-ray crystallography provided in the mineralogy course for Part 1 of the Natural Sciences Tripos at Cambridge. Emphasis was laid on the carefully prepared demonstrations and practical work and on the thoroughness of the teaching of the elementary ground-work, coupled with the Cambridge system of 'supervision' or private tuition. Dr. Wooster said that his Department would be pleased to try to

help other people setting up similar courses by supplying photographs, etc., for demonstrations. He concluded by describing the content of an advanced course which he would like to see established.

Dr. R. C. Evans described the Cambridge Summer Schools in X-ray analysis which had been run for a fortnight each summer for the last four years. He gave details of the content of the course, explaining the importance attached to fundamental principles and the practical work undertaken by the students. In the subsequent discussion, Miss O. Weisz asked whether the material of the Cambridge Summer School could be published. Dr. Evans said that only photographs, etc., were yet available, and Dr. Lipson said that he hoped soon, in conjunction with Dr. Wooster and Dr. Henry, to publish a book based on the Summer Schools.

Further discussion brought out the advantages of both advanced and 'refresher' courses, though some speakers doubted whether research workers could spare the time required for these.

Dr. A. Taylor directed attention to the difficulties under which many technical colleges are operating, but Mr. N. Tunstall explained that the Ministry of Education is well aware of the position and is making considerable progress towards its improvement.

New Methods and Results of X-Ray Analysis

Investigations of the structure of the related minerals kaolinite, halloysite and fire-clays were described by Dr. G. W. Brindley. The study of kaolinite using high-resolution powder cameras showed that the unit cell is triclinic, not monoclinic as had been previously reported. The cell contains one unit of the silicate layer structure, and the way in which the layers are packed can be decided unambiguously. The powder patterns of halloysite and meta-halloysite show bands as well as sharp lines, which indicate almost complete disorder as regards the orientation of the layers. Heat-treated halloysite loses water and the layers collapse to form meta-halloysite; in the latter the layer spacing is still greater than in kaolinite, indicating that some water may still be trapped between layers. The state of crystallization of the kaolin mineral in fire-clays is intermediate between that of kaolinite and halloysite.

Mr. C. W. Bunn discussed investigations of the structurally similar (6, 6) and (6, 10) nylons or polyamides. Squeezing the fibres causes the orientations of the crystals to simulate twinning, and from these specimens it is possible to determine the triclinic unit cell, and work out the atomic positions by trial and error. It has been found that the chain molecules, which have a planar zigzag configuration, are linked by hydrogen bonds to form sheets. The sheets can pack together in two ways to form either α-crystals which have a one-molecule triclinic cell, or β-crystals which have a two-molecule triclinic cell. However, streaks which appear on most fibre photographs indicate a certain degree of random change-over from α- to β-type of packing.

Dr. W. Cochran, in his paper on sucrose, pointed out that it is one of the few comparatively simple organic compounds for which the accepted stereochemical formula has never been confirmed by chemical synthesis. For this reason X-ray analysis of its structure has been attempted, but so far with no success. However, the structures of isomorphous addition compounds with sodium bromide and chloride have been completely solved by two-dimensional Fourier methods, and results indicate that the sucrose molecule can be described as 1-α-glucopyranose-2-β-fructofuranose. The accuracy of the analysis was judged by the agreement between observed and calculated electron density distributions.

Mrs. Hodgkin gave a general account of the investigation of the structure of penicillin, and paid tribute to all those who had assisted in this work. Before X-ray work started, the chemists had proposed several possible formulæ, including (1) 'oxazolone', (2) 'β-lactam', (3) 'tricyclic'. X-ray analysis began on the sodium benzyl salt, but no progress was made with this. It was, however, possible to find the atomic positions of the alkali atoms and also the sulphur atom in the potassium and rubidium salts. Meanwhile, Mr. Bunn tried the 'fly's-eye' technique on an 'oxazolone' structure, at that time favoured by chemists, for the sodium salt, and succeeded in getting a b electron-density projection which was partially correct. The b projections for all three salts were re-examined and a related set of peaks found in all of them which was assumed to represent the molecule. After that the work was comparatively straightforward, and a three-dimensional synthesis proved the molecule to have the 'β-lactam' structure. Mr. C. W. Bunn described how he had used the 'fly's-eye' technique in conjunction with Bragg-Lipson structure factor graphs, and also a new method arising out of the latter for refining atomic positions.

In the course of the discussion which followed, Dr. H. Lipson said that he believed that comparison of observed and calculated intensities is the only satisfactory method of checking the accuracy of a structure, and Prof. E. G. Cox thought that the factor

$$\frac{\Sigma(F_{obs}-F_{calc})}{\Sigma F_{obs}}$$

provides the most satisfactory check now available; although, as Mrs. Hodgkin pointed out, it is not completely reliable.

New Industrial Techniques and Results

The afternoon session was opened by Dr. J. Bailey, who gave examples of the application of X-ray crystallographic equipment to the solution of technical difficulties in metallurgical production.

Dr. T. Ll. Richards illustrated some metallurgical applications of the stereographic projection, including an analysis of the mechanism of recrystallization in cold-rolled 70/30 brass.

Dr. H. D. Megaw, giving the first of several papers on ferro-electric compounds, described these as having an abnormally high permittivity, analogous to the high permeability of ferromagnetic materials. Of the perovskite-type group of compounds, barium titanate alone shows a distortion of the ideal cubic structure that is not compatible with Goldschmidt's principles. Barium titanate shows a reversible second-order transition at $c.$ 120° C. to the ideal cubic form, and there are indications that there may be another transition at a low temperature. The transition from the cubic form is accompanied by characteristic multiple twinning.

Mr. M. J. Harwood described further work on the temperature variations of the barium titanate structure. He directed attention to the co-existence of both cubic and tetragonal phases in the region 120–125° C. Showing curves for the variation of cell dimensions of each phase with temperature, he explained the details by assuming that the lattice of

the new phase is at first built on that of the old, and that the stresses thus set up increase until they are relieved by the formation of the new phase as a separate structure.

Mr. H. F. Kay described some optical work on crystals of barium titanate which he had prepared from a melt. He had observed domains which were truly single-crystal, and had followed the changes occurring at the high-temperature transition and also at and below 0° C.

Dr. L. A. Thomas described how Wooster's method of removing the Dauphiné (or 'electrical') twinning of quartz by applied heat and stress, although in general effective, had in some cases proved unsuccessful. Instead of the twin boundaries being removed, the twinned areas may show regions of persistence which can be correlated to some extent with the darkening response to irradiation with X-rays.

Mr. H. S. Peiser discussed the determination of the amorphous : crystalline ratio in polythenes. Working to a standardized procedure, it is possible, by microphotometric intensity measurements of the amorphous and crystalline X-ray patterns, to compare the ratios for different samples to an accuracy of ± 3 per cent.

Dr. C. J. Brown described some of the organic structure determinations carried out in his laboratory. Anthranilic acid, sodium naphthionate, acetanilide, and the new synthetic fibre 'terylene', were among the structures described.

Dr. A. F. Wells directed attention to the increasing tendency of chemists to use the results of X-ray crystallography in an insufficiently critical manner, and pointed out the responsibility which this places on the X-ray worker.

Dr. W. J. Wrazej gave some results on the structure of retained austenite in plain carbon steels, which indicated that it should be regarded as a face-centred tetragonally distorted structure rather than face-centred cubic.

In the discussion which followed these papers, many points in connexion with the barium titanate structure were raised, it being evident that the mechanism of transition from the tetragonal to the cubic phase is still very imperfectly understood.

Annual General Meeting of the X-Ray Analysis Group

In his report as chairman of the X-ray Analysis Group of the Institute of Physics, Sir Lawrence Bragg reviewed the previous very successful year and described the steadily widening activities of the Group. Sir Lawrence now retires from the office of chairman, and Mr. D. A. Oliver (director of research, B.S.A. Group of Companies) succeeds him. It was agreed to request the Board of the Institute of Physics to approve the creation of the office of vice-chairman, and Dr. W. H. Taylor (Crystallographic Laboratory, Cavendish Laboratory, Cambridge) was elected. Mr. J. N. Kellar (Crystallographic Laboratory, Cavendish Laboratory, Cambridge) was elected honorary secretary in succession to Dr. F. A. Bannister. Dr. H. Lipson, Mr. H. P. Rooksby and Dr. A. J. C. Wilson retired from the Committee, and Dr. R. C. Evans, Dr. T. Ll. Richards, Prof. J. M. Robertson and Prof. W. T. Astbury were elected, the last subject to the Board of the Institute agreeing to augment the membership of the Committee by one.

The business of the meeting was followed by reports, given by Dr. W. H. Taylor, Dr. R. C. Evans and Dr. F. A. Bannister, on the work of the equipment panels set up in the latter part of 1946. The Fourier Service Panel has concluded that the demand for a central calculating service is not large enough to justify setting up a special organisation, and those requiring assistance can apply direct to Dr. L. J. Comrie's organisation. New and improved Beevers–Lipson strips are being prepared. The X-ray Tube Panel, having made a general inquiry of users in Great Britain, has prepared a user specification for an 'ideal' demountable hot-cathode X-ray tube, but is taking no action in this matter beyond passing certain recommendations for improvement to the Raymax and Hilger sets to the appropriate firms. Specifications for moving anode and sealed-off tubes are being prepared. The Single Crystal Camera Panel is proceeding with a specification for a Weissenberg-type camera. The Powder Camera Panel is proceeding to design and prepare prototypes of a high-temperature camera, with the help of Mr. Oliver's organisation. Dr. W. H. Taylor announced that it is hoped to receive, through the Ministry of Supply, a number of sealed-off Philips tubes from Germany to fill the gap before tubes can be produced in Britain. Panels to deal with crystal structure models and miscellaneous equipment have also been set up.

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PRODUCTION OF ANTIBIOTICS BY *FUSARIA*

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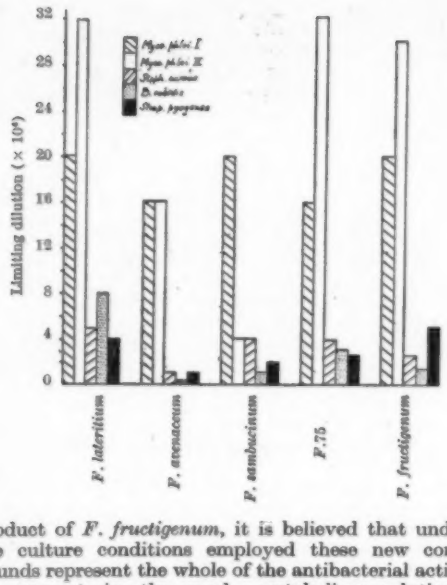
EARLIER communications[1,2,3] described the production of an antibiotic pigment, javanicin, by *Fusarium javanicum*, and other *Fusaria* were also observed[1] to give rise to antibiotic metabolism solutions. So far, the examination of twenty-two *Fusarium* strains has revealed a frequent property of this kind; for convenience the moulds may be divided into groups according to the kind of activity exhibited by the crude culture fluids.

Group I, equally active against *Mycobacterium phlei* and *Staphylococcus aureus*: *F. javanicum*, *F.6*, *F.64* (*F* numbers refer to strains which are as yet unidentified).
Group II, more active against *Myco. phlei* than against *Staph. aureus*: *F. lateritium*, *F. avenaceum*, *F. sambucinum*, *F. dianthii*, *F. fructigenum*, *F.63*, *F.75* (probably a further strain of *F. lateritium*).
Group III, active against *Myco. phlei*, inactive against *Staph. aureus*: *F. culmorum* (Str. 61), *F.72*, *F.91*, *F.101*.
Group IV, inactive against both *Myco. phlei* and *Staph. aureus*: *F. oxysporum cubense*, *F. culmorum* (2nd strain), *F. cæruleum*, *F.8*, *F.10*, *F.26*, *F.73*, *F.88*.

Clearly this classification may depend on the cultural conditions employed, and it would in any event be less significant if the varying activities were merely due to varying proportions of two antibiotics or classes of antibiotics. Closer examination, however, has afforded chemical evidence which suggests that this division may reflect a more fundamental biochemical grouping.

The antibiotics produced by *F. lateritium*, *F. avenaceum*, *F. fructigenum*, *F. sambucinum* and *F.75* (probably also a strain of *F. lateritium*) (Group II above) under selected conditions have now all been isolated in pure crystalline state. Excepting the



product of *F. fructigenum*, it is believed that under the culture conditions employed these new compounds represent the whole of the antibacterial activity present in the crude metabolism solutions. Naming them conventionally according to the species from which they are derived (that from *F.*75 being provisionally termed lateritiin-II) these compounds are quite distinct, the melting point of a mixture of any two being depressed: Lateritiin-I, $C_{25}H_{44}O_7N_2$, m.p. 121–122°; lateritiin-II, $C_{25}H_{44}O_7N_2$, m.p. 125°; avenacein, $C_{25}H_{44}O_7N_2$, m.p. 139°; fructigenin, $C_{26}H_{44-46}O_7N_2$, m.p. 129°; sambucinin, $C_{24}H_{42}O_7N_2$, m.p. 85–86°. These formulæ are regarded as subject to some revision of detail, though each is based on repeated concordant analyses. The compounds are also distinct in their antibacterial properties, as appears from the differing 'bacterial spectra' in the accompanying graph.

On the other hand, the compounds are so similar in chemical behaviour as to leave no doubt that they owe their biological activity to similar structural features. They are colourless, optically active, neutral, and sparingly soluble in water, but very soluble in organic solutions including light petroleum. All are stable to mineral acids under ordinary conditions, and to heat; indeed, lateritiin-I could be distilled *in vacuo* without chemical change occurring. However, all are very unstable to alkali, so that all antibacterial activity is irreversibly lost in solution at $pH = 10–11$ at room temperature after 18 hours. During this inactivation approximately two acid groupings per molecule are produced but disappear again, possibly by lactonization, when attempts are made to isolate the primary inactivation product. The group of compounds is otherwise notable for its lack of easily recognizable structural features. Thus avenacein contains no acidic, basic, carbonyl or alkoxy groups, nor any active hydrogen atoms detectable by the usual means. It does, however, contain two N-methyl and four C-methyl groups. When the compounds are heated with concentrated hydrochloric or hydrobromic acid at 120°, they are degraded to optically active crystalline bases which contain all the nitrogen present in the antibiotics. In addition, each of the antibiotics gives rise to the same crystalline acid, $C_5H_{10}O_2$; in the case of lateritiin-I the yield approaches that corresponding to the formation of two molecules of acid. The latter has been completely identified as the optically active α-hydroxy*iso*valeric acid corresponding to *d*(-)valine. To the best of our knowledge this acid has not previously been obtained directly from any natural source. It is interesting to note its correspondence with the amino-acid and particularly its retention of optical activity, the configuration being the 'unnatural' one.

Attention was specially directed to these antibiotics because of their action against *Myco. phlei* and possibly, therefore, against *Myco. tuberculosis*. Tests with lateritiin-I against three strains of tubercle demonstrated *in vitro* inhibitions at limiting dilutions of 1 : 160,000–1 : 640,000, indicating a high activity. Mouse experiments pointed to relatively low toxicity, at least by intraperitoneal administration. We are indebted to Drs. P. D'Arcy Hart and R. E. Glover (National Institute for Medical Research) for these results, but any therapeutic possibilities remain largely to be explored.

It has been noted that these *Fusarium* antibiotics are best produced when the mould is in a somewhat metabolically degenerate state. Perhaps such antibiotics are normal but mostly transient metabolic products, which only accumulate in sufficient quantities to permit of their recognition and isolation under abnormal culture conditions. It may perhaps be further envisaged that more deliberate induction of a moderately degenerate state may afford a degree of control over antibiotic production. Finally, it is worth noting that the above compounds appear to be products of an arrested metabolism exerting an antibiotic action on other presumably similar though obviously distinct metabolisms. The fact appears to offer perhaps profitable speculation on the mechanism of such manifestations of interference.

Full details of the above work will be published elsewhere. We are indebted to the Medical Research Council for assistance, and to Sir Ian Heilbron for his interest and encouragement.

[1] Cook, A. H., and Lacey, M. S., *Brit. J. Exp. Path.*, **28**, 404 (1945).
[2] Arnstein, H. R. V., Cook, A. H., and Lacey, M. S., *Nature*, **157**, 333 (1946).
[3] Arnstein, H. R. V., and Cook, A. H., *J. Chem. Soc.*, in the press.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

ANNUAL REPORT

THE annual report of the National Institute of Economic and Social Research for 1945–46 welcomes the recommendations of the Clapham Committee and particularly the declaration in that Report as to the national importance of the realistic studies to which the Institute has consistently devoted itself. Commenting on the new approach to economic problems illustrated by the elaboration of national income studies, the Institute's report points out that in Britain, in spite of sharp disagreement about particular methods and policies, there is a considerable measure of agreement about the ultimate goals of economic and social policy and the intellectual terms in which these problems may most profitably be set out, discussed and investigated. Moreover, the Institute has been able, through its Occasional Paper No. X, "A System of National Book-keeping:

Illustrated by the Experience of the Netherlands Economy", by Prof. J. B. D. Derkson, to make available to English readers some of the basic researches behind developments in economic planning in Holland, and it has also provided a meeting-place for the discussion of technical aspects of such problems between official representatives from Norway and Sweden and those engaged in similar work in Britain.

The immense tasks which face the advisers of Government call for a wealth of factual, quantitative information about the British economy and its development in the recent past which cannot be supplied entirely from official sources, and the contribution of the Institute in this field is of increasing importance. Of particular significance in this connexion, through its bearing on the structure and productivity of the national economy, is the inquiry on the "National Expenditure, Output and Income, 1920–38", which continued to be directed by Mr. Richard Stone. A first volume containing the results of the investigation into consumers' expenditure is already in the hands of the printers: as is a report on "Productivity, Prices and Distribution in Selected British Industries". A second report from the same investigation, "International Comparisons of Productivity in British and American Manufacturing Industry", is now being finally prepared for publication, while during the year work was started on the distribution inquiry with the aim at the first stage of building up a factual picture of the channels by which consumer goods passed from the manufacturer to the public in the immediate pre-war period. The second stage of the inquiry is concerned with the more difficult problem of the functions, stock turn, and cost and profit experience of different types of wholesaler and retailer. Late in 1945 a building inquiry was commenced, under Mr. I. Bowen, covering the structure and efficiency of the building industry, housing demand and the building cycle, and economic problems arising from new building techniques. Main attention is being given to the first topic, and it is hoped that a report on this part of the programme will be completed during 1947.

The work on capital formation and public authority expenditure has continued, attention so far having been concentrated on the current and capital expenditure of local authorities. The inquiry into disease mortality and its changing distribution has issued in a draft report "The Social Geography of Mortality in England and Wales, 1911–38"; but Dr. Kuczynski's study of post-war population problems has been suspended while the Royal Commission on Population is in session. The inquiry into advertising has been completed, and a report on "Statistics of Advertising" is to be published later. Miss P. M. Deane completed her Occasional Paper, "The Measurement of Colonial National Incomes: an Experiment", before taking up her field experiments as a Colonial research fellow in Africa. A joint exploratory committee with representatives of the Institute of Chartered Accountants has considered the field of work in which accountants and economists have a common interest, and it is hoped to publish later an agreed statement of its findings. Senior research fellowships were awarded during the year, under the scheme described in last year's report, to Mr. E. J. M. Buckatzsch for an inquiry into "Factors Affecting Income per Head in Towns and Areas in England and Wales, 1929–1939", to Miss K. Liepmann, for an inquiry into "The Extent and Composition of Labour Markets in Selected Areas in the South West", and Mr. H. G. Schenk's part-time fellowship has been extended to enable him to complete his inquiry into "European Romanticism and the Social Revolution, 1790–1830". The Register of Research in the Social Sciences for 1940 is being distributed as a confidential document. New Institute publications during the year are listed in the report.

SALMON MIGRATION AT SEA

THE Buckland Foundation Lecture was given by J. W. Menzies at the University of Liverpool, on May 28, Prof. J. H. Orton presiding. Taking for his subject "The Migrations of Salmon in the Sea", Mr. Menzies summarized the information learned from the experiments of marking salmon in Scottish, Norwegian, Baltic, and Canadian haunts, and suggested that European and Canadian salmon have a common feeding ground in the North Atlantic near Iceland, where a new marking station will probably be opened under international co-operation in a few years time. The only area where *Salmo salar* has been traced from the river of origin to its feeding ground in the sea and then back to the river as adult fish is the Baltic, where Swedish marking experiments showed that smolts left the northern Swedish and Finnish rivers in spring when only 5 in. long and reached the southern Baltic, 600–800 miles away, in October and November, when they weighed just over a pound after feeding; but they did not show evidence of passing out of this belt into the North Sea. Salmon apparently do not feed in the North Sea, or The Minch of western Scotland, or they would have been caught more often in the herring nets. The Swedish salmon feed in the southern Baltic for possibly up to two or three years before returning to their native rivers.

Salmon marked in the Gulf of St. Lawrence, and off the shores of Scotland and Norway, have shown two types of movements. In one they have been recovered after they have nearly completed their journey home again, when they remain off the river until a flood induces them to ascend. They cease feeding once they reach the coast, and if a drought keeps them there some weeks or months, they lose weight, a 15-lb. fish losing 2–3 lb. in a little more than two months while waiting to ascend the river; a 15-lb. fish lost 4 lb. in 67 days; a 12-lb. fish lost 2 lb. in two months. Only five marked fish were recovered more than ten miles from Thurso Bay, and marking showed a similar restricted movement in the inner Moray Firth; only six out of more than 400 strayed outside the outer limits of the Firth, and there were similar results from Canada and Norway.

Other salmon, particularly those marked off south-west Newfoundland, western Scotland and western Norway, made long journeys to the place of capture, the record being a St. Lawrence fish caught as a clean fish in sea nets 2,000 miles away up the Labrador coast, while from near the north of Norway an easterly migration has been traced to the River Petchora, the easterly limit in the distribution of *Salmo salar*. In both Canada and Scotland these long journeys have often been four or six hundred miles, and on the Norwegian coast 1,600 miles to the White Sea. Marked salmon have travelled between Scotland and Norway, but not across the Atlantic, so far as recoveries show; but all these fish seem to be going back to the river from which they came as smolts.

Marking not only indicates the length of migration, but also the speed, and the longer the migration the faster appears to be the speed, especially with Norwegian records, one of which was recovered 680 miles away in a little more than ten days, a speed of 62 miles per day. Adult salmon in the sea travel at a minimum rate of between ten and twenty-five miles a day.

Mr. Menzies suggested that the cause of the very poor salmon season of 1945 in Britain probably lay in feeding conditions at sea, not in fresh-water rivers, because in Iceland, Norway and Canada this was also a bad season. When swimming near the coast, salmon travel within 7 ft. of the surface; but although herring and sand-eels have been found in them, very little is known of their diet in the sea, and those caught near the shore were almost invariably empty.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, July 7—Wednesday, July 9

UNIVERSITY OF BRISTOL (at the H. H. Wills Physical Laboratory, Royal Fort, Bristol), at 9.30 a.m. and 2.45 p.m. each day.—Conference on "The Strength of Solids".

Monday, July 7—Thursday, July 10

ROYAL SOCIETY, GASSIOT SUB-COMMITTEE B (at Burlington House, Piccadilly, London, W.1).—Conference on the "Emission Spectra of the Night Sky and Auroræ".

Monday, July 7

At 11 a.m.—Prof. S. Chapman, F.R.S.: Opening Address.

Monday, July 7—Saturday, July 12

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH and EAST OF SCOTLAND SECTIONS (at The University, St. Andrews).—Symposium on "Coal, Petroleum and their Newer Derivatives".

Tuesday, July 8

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. D. Rittenberg (Columbia University): "The Application of the Isotope Technique to some Biochemical Problems".*

Wednesday, July 9—Saturday, July 12

SOCIETY FOR APPLIED BACTERIOLOGY (at Reading).—Annual General Meeting and Paper Reading Conference.

Wednesday, July 9

At 8 p.m. (at St. Andrews Hall).—Annual General Meeting.

Thursday, July 10

At 10 a.m. (in the Zoology Lecture Theatre).—Symposium on "Water Bacteriology"; at 2.15 p.m.—Paper Reading Conference.

Friday, July 11

At 10 a.m.—Paper Reading Conference.

Thursday, July 10—Saturday, July 12

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Physics Department, The University, Manchester).—Conference on "Applications of Radioactive Tracer Elements in Physics Research and Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN TEXTILE TECHNOLOGY, and a LECTURER IN MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester (July 12).

SENIOR ASSISTANT (with a good Honours degree) IN THE DEPARTMENT OF CHEMISTRY, a LECTURER IN PHARMACY, a LECTURER (with a good Honours degree or its equivalent) IN MATHEMATICS, SENIOR ASSISTANTS (3) IN (*a*) DESIGN SECTION, (*b*) PRODUCTION ENGINEERING SECTION, (*c*) for RESEARCH AND EXPERIMENTAL WORK, and LECTURERS (2) for (*a*) DESIGN SECTION, (*b*) PRODUCTION ENGINEERING SECTION, in the Department of Mechanical Engineering, LECTURERS (2) in ELECTRICAL ENGINEERING up to Higher National Certificate standard, and LECTURERS (2) in (*a*) CARPENTRY AND JOINERY, (*b*) PLUMBING AND SANITARY ENGINEERING, in the Department of Building and Structural Engineering—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (July 12).

LECTURER IN ZOOLOGY AND CHEMISTRY—The Registrar, Merchant Venturers' Technical College, Bristol (July 12).

LECTURER IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (July 12).

LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (July 14).

LECTURER IN MATHEMATICS in the United College—The Secretary, The University, St. Andrews (July 15).

LECTURER IN GEOLOGY (Petrology and Mineralogy) in University College, Dundee—The Secretary, The University, St. Andrews (July 15).

LECTURER IN ZOOLOGY to take charge of the Gatty Marine Laboratory—The Secretary, The University, St. Andrews (July 15).

LECTURER IN PHYSICS, and a LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 19).

LECTURER, and an ASSISTANT LECTURER, IN PHYSICS—The Secretary, King's College, Strand, London, W.C.2 (July 21).

ADVISER IN AGRICULTURAL ECONOMICS, a SENIOR AGRICULTURAL ECONOMIST, and an ASSISTANT AGRICULTURAL ECONOMIST—The Registrar, The University, Manchester 13 (July 26).

LECTURER IN THE TECHNICAL DEPARTMENT, for City and Guilds Telecommunications up to Grade 5—The Technical Officer, University College, Southampton (July 26).

LECTURER (Grade II) or ASSISTANT LECTURER (Grade III) IN PHYSICS—The Registrar, University College, Southampton (July 26).

LECTURER IN PHILOSOPHY in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 30).

DAIRY OFFICER IN THE DEPARTMENT OF AGRICULTURE AND LANDS, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (July 31).

STATISTICIAN in the office of the Town Clerk—The Town Clerk, Town Clerk's Office, Room 30B, Council House, Birmingham 1, endorsed 'Central Statistical Officer' (July 31).

ZOOLOGISTS (4) with special experience of taxonomic work on (*a*) mammals, (*b*) fishes, (*c*) arachnida, and (*d*) mollusca, and ENTOMOLOGISTS (4) with special experience of taxonomic work, at the British Museum (Natural History)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1936 (July 31).

UNIVERSITY LECTURER IN PHYSICS—The Secretary of the Appointments Committee, Faculty of Physics and Chemistry, Chemical Laboratory, Pembroke Street, Cambridge (July 31).

LECTURER IN PATHOLOGY—The Registrar, The University, Sheffield (July 31).

DIRECTOR OF RESEARCH for the development of Rheumatism Treatment and Research, and a RESEARCH FELLOW IN THE SURGERY OF RHEUMATISM—The Registrar, The University, Leeds (July 31).

SOIL BIOCHEMIST, a PHYSICAL CHEMIST with experience in a colloid laboratory or used to X-ray technique, a PHYSICAL CHEMIST with experience in spectroscopic or polarographic techniques, a SOIL CHEMIST with general soil experience, and a SOIL CHEMIST with some training in botany as well as chemical experience, in the Soil Bureau, Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (August 1).

JUNIOR PHYSICO-CHEMIST for bacteriological and virus research work—The Secretary, Inoculation Department, St. Mary's Hospital, Paddington, London, W.2 (August 1).

ASSISTANT LECTURER IN THE DEPARTMENT OF EMBRYOLOGY—The Secretary, University College London, Gower Street, London, W.C.1 (August 1).

SENIOR RESEARCH OFFICERS (2), RESEARCH OFFICERS (12), ASSISTANT RESEARCH OFFICERS (6), and RESEARCH ASSISTANTS (7), in the Ministry of Town and Country Planning—The Secretary, Ministry of Town and Country Planning, 32 St. James's Square, London, S.W.1 (August 15).

STATISTICIAN—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

GAME RANGER (with a science degree, preferably in zoology) in Tanganyika Territory—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

RESEARCH STUDENT IN SOIL SCIENCE—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

LIBRARIAN—The Assistant Secretary, Royal Anthropological Institute, 21 Bedford Square, London, W.C.1.

LECTURER (Grade III) IN THE DEPARTMENT OF CHEMISTRY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

RESEARCH CHEMIST—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

DIRECTOR OF RESEARCH—The Chairman, British Welding Research Association, 29 Park Crescent, London, W.1, endorsed 'Director'.

RESEARCH ENGINEER for research on machinery used in the clay industry—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on-Trent.

TECHNICIAN FOR BIOCHEMICAL DEPARTMENT—The Bursar, The University, Sheffield 10.

SENIOR ASSISTANT, and a LECTURER, IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18.

LECTURER IN TELECOMMUNICATIONS, with specialist knowledge in Radio Engineering—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Gazetteer of Great Britain: giving the Position of Towns and Important Villages shown on Ordnance Survey Maps in terms of the National Grid. Pp. 54. (Chessington, Surrey: Ordnance Survey, 1946.) 5*s*. [231

Alkali &c. Works Regulation Act, 1906, and Alkali &c. Works Orders 1928–1939: Eighty-second Annual Report on Alkali &c. Works. By the Chief Inspectors. Proceedings during the Years 1939–1945 inclusive. Pp. 48. (London: H.M. Stationery Office, 1947.) 1*s*. net. [291